"OBSERVATIONS ON THE USE OF PROTEIN HYDROLYSATES IN MEDICAL AND SURGICAL CASES."

A Thesis

Submitted by

BARBARA H. BILLING, B.A. (Cantab.)

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CONTENTS.

INTRODUCTION.

The Hippocratean theory, that there was a specific universal nutrient in food, persisted until the beginning of the 19th century when, with the development of new chemical techniques, the existence in food of a variety of unlike substances was recognised. These techniques enabled Lavoisier to carry out metabolic experiments as the result of which he declared in 178o that "La vie est une fonction chimique." He believed that organic substances were composed of carbon, hydrogen and oxygen. In 1786 Berthollet showed that nitrogen was a constant constituent of animal tissues and by 1834 the importance of the nitrogenous matter in food had been realised by Prout, who had made the first analysis of proteins in 1830, and by the French physiologist Magendie. Liebig, by his perfection of methods for the quantitative determination of carbon hydrogen and nitrogen in organic compounds, enabled the composition of food, urine, faeces, and tissues to be determined so that in 1839 Boussingault /

Boussingault was able to make a balance of intake and outgo of nutrients in food and excreta, using a cow as his subject. C. Voit (1866), in confirmat--ion of previous work by Bidder and Schmidt (1852), showed that the difference between the amount of nitrogen ingested by a dog on a meat diet and that recovered in the excreta was only 0.3%. The view, originally postulated by Liebig (1842), that the nitrogen of the urine and the faeces could be made a measure for the determination of protein metabol--ism was thus established.

The development of the nitrogen balance technique resulted in extensive studies being made of the protein and thus the food requirements of man as well as animals, for as Rubner has stated "Protein contains the magic of life, ever newly created and dying, a process continuous since the advent of life upon earth." The Munich school of physiologists under C. Voit set the average protein requirements of a man at 118 gm. a day, with 145 gm. for a man doing hard work, while Attwater in America recommended 125 gm. a day for a man doing normal work. McCay (1912), in his studies of the dietaries of various peoples in Inda, where the daily protein consumption varied /

varied from 67 g. for a Bengali student to 160 g. for the Bhutias, concluded that "the higher the level of protein interchange the more robust and energetic and the more manly the race."

Meanwhile, M. Rubner (1883) had demonstrated that the protein metabolism of a fasting dog could be reduced to 40% of the total calories needed, if adequate amounts of carbohydrate were provided. Lusk (1890) continued this work by showing that the carbo-hydrate content of the diet affected protein metabolism, and thus the protein requirements. In his experiments, withdrawal of 350 g. of carbohydrate from diets of 20.55 g. nitrogen and 2953 Cals. and 9.23 nitrogen and 2,490 Cals. which had maintained nitrogen equilibrium, so as to give diets containing 1,078 Cals. and 615 Cals. respectively, resulted in negative nitrogen balance. Landergreen was able to reduce the daily urinary nitrogen excretion of a man to less than 4 g. a day by the administration of carbohydrate and fat; if fat only was given at an equicaloric level, the protein metabolism was the same as in starvation. Zeller (1914) confirmed this work when he found that protein metabolism was not significantly altered by the relative proportions of fat /

fat and carbohydrate in the diet, unless less than 10% of the total calories was given in the form of carbohydrate.

With regard to the protein sparing action of carbohydrate in a normal diet, the necessity for supplying the carbohydrate within a few hours of the protein food has been clearly demonstrated in recent years by Larson and Chaikoff (1937), Geiger (1947) and Henry and Kon (1946). The mechanism of this protein sparing (action of carbohydrates) is still not fully understood. It is probably due to the prevention of the formation of glucose from amino acids, the supplying of total caloric needs in a form of a fuel which is mobile and readily available, and also to the provision of chemical groupings easily convertible to amino acids. Appreciation of the part played by carbohydrate and fat in protein metabolism resulted in the questioning of the desirability or necessity of such protein intakes as those recommended by Voit and Attwater. Hirschfeld (1888) remained in nitrogen equilibrium for a fort-night on a daily protein intake of 40 g. and E. Voit found vegetarians to be in nitrogen equilibrium on a diet /

diet providing 50 g. of protein a day, augmented by fats and carbohydrates to meet their energy require--ments. Chittenden (1905) describes experiments, covering periods of over 6 months, in which a careful record was kept of the food consumed, and the excreta were chemically analysed, of 5 brain workers, 13 soldiers and 8 university athletes, who worked hard both mentally and physically, while on low protein diets. Chittenden himself,who weighed 57 kg., maintained nitrogen equilibrium and claimed to have improved his health on a daily intake of 36 g. of protein and 2,000 Cals.,while another laboratory worker was in equilibrium on 41 g. of protein. The soldiers and athletes were in equilibrium on 50 and 55 g. of protein respectively and less than 2,800 Cals. and remained in excellent health.

Opposition to this point of view was expressed by many nutritionists, including Crichton-Brown (1909), who asserted that "successful races habitual--ly consumed protein far in excess of the Chittenden standard and far in excess of what is required for tissue repair, and when we find a relation between protein consumption and racial success, there is good /

good ground for believing that there is a biological law." E. Terroine (1936) suggested that the protein requirements need only be sufficient to replace specific endogenous nitrogen excretion, i.e. 18.75 g. of protein, a figure which is considered by most workers to be unobtainable and unjustifiable. Sherman (1935),as the result of nitrogen balance experiments on low intakes, considered a daily intake of 44.4 g. of protein to be adequate for a 70 kg. man. Schmidt (1933) lived at this level for over 2 years, during which period he concluded that human efficiency could be maintained, but after that time changes could be detected in his temperature, pulse and skin; he therefore considered 60-80 g. of protein desirable in the daily intake of food. Susskind, a co-worker of Rubner also broke down after 2 years on a diet containing 32-45 g. of protein a day. Cuthbertson (1940), in his review on this subject,was unable to give an answer to the question "what are the optimal protein requirements of man?" but weighed up the evidence in favour of a relatively high protein diet. During the recent war the National Research Council (1943) recommended minimal intakes of 70 g. of protein daily for the normal healthy adult. The protein requirements of the convalescent patient will have to be /

be considered separately.

By the beginning of the twentieth century, chemical methods for the analysis of proteins had been developed to enable the amino acid content of a particular protein to be determined. The classic experiments of Hopkins (1906) and Osborne and Mendel (1911) showed that the nutritive value of a specific protein depended on its amino acid content. Previous-ly, it had been shown that nitrogen equilibrium could be maintained in a dog fed on pancreas, which had been self-digested until all the protein had been converted into amino acids, fat and carbohydrate (Loewi 1902). Two years later Aberhalden and Rona (1904) published work in which they showed that mice could live on a diet of casein, split by pancreatin, as long as they could on casein alone, and longer than they could on casein subjected to acid hydrolysis. Nitrogen equilibrium was established in dogs on a diet of non-protein food and a pancreatic digest of casein, containing 2 g. of nitrogen a day. It was thus apparent as Lusk (1928) has written that "amino bodies from certain proteolytic cleavages may be the equival-ent in metabolism of ingested protein itself." Recent confirmation of this work has been provided by Cox and Mueller (1939) who obtained nitrogen balances of /

of approximately the same magnitude in rats for over 140 days, regardless of whether the nitrogen of the diet was supplied by casein, an enzymic digest of casein, or an acid hydrolysate of casein supplemented with 0.2% tryptophane.

The value of feeding protein hydrolysates in certain pathological conditions was therefore consider-ed and the possibility of using the intravenous route explored. This method of feeding had been used in 1665 when R. Lower first attempted blood trans-fusions. In 1832 Latta used this same route for the replacement of water and salt, and in 1873 a series of observations were made on the intravenous injections of milk in the treatment of cholera by Hodder (1873), though no further reference to this method can be found after 1883. Friedrich (1904) described experiments in which injections were used containing all of the nutritional substances except the then unknown vitamins. In a variety of surgical conditions which precluded the ingestion of food by mouth, solutions containing water, salt, carbohydrate, fats and peptone, which had been prepared by the peptic digestion of fibrin, were injected subcut-aneously. This first successful usage of a protein hydrolysate/

hydrolysate for clinical purposes by the intravenous route was unfortunately not followed up, though Woodyatt, Sansum and Wilder (1915) showed that the injection of glucose solutions constituted a method of intravenous nutrition and they expressed the belief that the way was now open for other foods. Early failures in the use of this technique for feeding were largely due to lack of knowledge of the necessary physiological, bacteriological and chemical facts.

Meanwhile, V. Henriques and Anderson (1908), in an endeavour to find the site of protein synthesis, had described the first really successful experiment in which an animal, in their case a goat, had been kept in positive nitrogen balance for 20 days with a continuous intravenous drip containing glucose, salts, and an enzymic hydrolysate of meat as its only source of nutrition. Earlier workers with acid and alkali hydrolysates had for the most part been unsuccessful owing to the methods of their production and to the fact that it was not until later that Hopkins (1916) recognised that acid hydrolysis of casein causes the destruction of tryptophane, an essential amino acid for adequate nutrition.

In /

In 1937 interest was once again renewed in the possibility of parenteral feeding using protein hydrolysates. Elman (1937) produced evidence that in dogs, protein-depleted by acute haemorrhages, serum protein regeneration was greater following the injection of a mixture of amino acids, prepared by complete acid hydrolysis of casein with the addition of 2% tryptophane and 2% cystine. The supplementary amino acids had to be given at the same time as the hydrolysate in order to obtain nitrogen equilibrium in the dogs (Elman 1938). The injections were well tolerated, unless given too quickly, and post-mortem findings gave no evidence of histological changes occurring in the liver or kidney. This work was repeated with success in humans, who were incapable of taking food by mouth; dosages amounting to 0.5 g. of amino acids per kg. body weight were given and each litre of solution administered contained 20 g. of amino acids and 80 g. of dextrose. (Elman and Weiner 1939). Improvement in the clinical condition of the patients was observed, together with relief of nutritional oedema and some regeneration of serum proteins, while balance experiments indicated that the nitrogen requirements of the body could be met in this manner.

In /

In 1939 there also appeared the first clinical report of the use of an enzymic hydrolysate of casein which had the advantage over the acid hydrolysate in that it did not need the addition of tryptophane, an expensive amino acid; in this preparation only 50-70% of the protein is completely hydrolysed and a proportion of peptides are administered in addition to the amino acids. Shohl et al. (1939) observed positive nitrogen balances in 5 of 6 two day periods when infants were given this hydrolysate intravenously, the degree of nitrogen retention being practically the same as that obtained with milk containing a similar amount of nitrogen. Elman (1940) described the intravenous use of this enzymic hydrolysate of casein (Amigen) for periods of 2-23 days, as the sole source of nitrogen, in 35 adult patients. Dosage varied from 1-2 g. of nitrogen per kg. of body weight and 300-400 g. of glucose were given intravenously as a 10% solution in order to meet the caloric requirements. In a normal individual positive nitrogen balances often amounting to almost 4 g. a day were achieved for 12 days on 60 g. of Amigen (equivalent to 45 g. of protein). Dramatic clinical improvement was recorded in some of these cases, together /

together with positive nitrogen balances, and though in some of the early preparations pyrogenic reactions were encountered, the injections were on the whole well tolerated. Increases in the albumin fraction of the plasma proteins were observed in some cases, and this supported the evidence later obtained from animal experiments, using dogs, that enzymic digests of casein given intravenously are capable of promoting plasma protein regeneration. (Brunschwig 1942, Elman 1943, Whipple 1941).

The maintenance of nitrogen equilibrium by the administration of intravenous Amigen, in total parenteral feeding, for periods of up to 8 weeks has been reported (Brunschwig 1945 and Reifenstein 1945). There is, therefore, little doubt that as a source of nitrogen Amigen is nutritionally adequate.

It has been observed that tissue protein is lost following extensive trauma, burns, surgical operations and in various types of infection, due to a phenomenon, the nature of which is poorly understood and which is spoken of as "Toxic destruction of protein," or the "catabolic phase." It was first described and studied in typhoid fever by Schaffer and Coleman (1909), while Wernheimer (1919) observed, after a period of shock, that there was an increased urinary /

urinary urea excretion, which remained at a high level for some time. Its significance in surgical patients has been emphasised by Cuthbertson. He showed in normally healing fracture cases that there is a marked loss of nitrogen, phosphorus and sulphur in the urine, which may continue for well over a month, but which is maximal about the second to the fifth day after the fracture has been sustained (Cuthbertson 1929, 1930, 1931, 1932). The relative amounts of substances excreted suggested that the material catabolised was probably muscle protein. Total losses of nitrogen amounted in some cases to over 220 g. of nitrogen (equivalent to 15 lbs. of muscle). High protein diets for these patients were indicated but with diets containing daily intakes of 23-36 g. of nitrogen and caloric intakes of 3,044-3,606 Cals., Cuthbertson (1936) was unable to obtain nitrogen equilibrium, though he did find that the relative nitrogen loss was less with the higher protein intakes. Howard (1944) has confirmed Cuthbertson's results in nitrogen balance experiments carried out on healthy male patients after fractures and skeletal operations. A similar pattern of changes in urinary excretion has been shown to occur following other surgical procedures /

procedures (Elman 1940, Brunschwig 1942, Co Tui 1944).

Attempts have been made to prevent this excessive nitrogen loss. Madden and Whipple (1944) contend that plasma proteins are the medium of exchange between the various body proteins, so that it seemed justifiable to give plasma infusions in order to maintain nitrogen equilibrium following operation. Marked positive balances, with temporary rises in plasma proteins, have indeed been observed as the result of such treatment (Elman and Lischer 1943, Madden and Whipple 1944, Meyer et al. 1947) but as Eckhardt et al. (1948), in their study of the nutritive value of administered human serum albumin, have emphasised, its action is delayed and its utilisation extends over many days so that the beneficial effect, if any, is difficult to assess.

Oral feeding of high protein diets is often an impractical procedure following operation, but with the development of parenteral protein feeding the administration of such diets is at least a theoretical possibility. Studies have been made to see how they affect the so-called "nitrogen catabolic phase" and if it can be prevented. Claims to have obtained nitrogen equilibrium following severe surgical operations /

operations, in the majority of cases as the result of the administration of massive amounts of Amigen and Glucose both orally and intravenously, have been made by some workers (Mulholland 1943, Co Tui 1944, Riegal 1945, 1946). Peters (1944) Brown et al. (1944) and Howard (1944) have however been unable to prevent a negative nitrogen balance occurring after operation.

The study to be reported in this thesis was begun in 1946 in an endeavour to see how far the protein requirements of a patient are affected by such operations as that of partial gastrectomy, and to what extent these requirements can be supplied by oral, intravenous and intrajejunal feeding. It was proposed to investigate the possibility of abolishing the nitrogen catabolic phase, or at least of minimising it, and to obtain information as to the value, or otherwise, of British preparations of enzymic casein hydrolysates for oral and intravenous use in surgical treatment. Co Tui (1944) had report--ed the successful treatment of patients suffering from peptic ulcers by the oral administration of large doses of Amigen and Glucose and attempts were made to confirm his results.

The /

The preliminary work consisted mainly of nitrogen balance studies, but it was observed that, despite apparently adequate salt intake, a period of low salt excretion almost invariably accompanied the periods of negative nitrogen balance. The investigations were, therefore, extended to see if there was any correlation between the periods of salt retention and protein catabolism which follow operation, and to what extent the one influenced the other.

METHODS.

PREPARATION OF SPECIMENS FOR ANALYSIS.

Urine.

Unless otherwise stated, all analyses of urine were carried out on samples of urine taken from a complete 24 hours specimen, the volume of which was carefully measured. Suitable dilutions of the urine were made for the various estimations, which were performed immediately.

Faeces.

Faeces and enema returns were collected in 24 hours specimens and were analysed daily in most instances. Using a Warburg blender, a relatively homogeneous solution was obtained which was made up with distilled water to 1,000 or 2,000 ml. in a volumetric flask. Aliquots of this solution were then used for analysis.

Gastric aspirations and vomitus.

The volume of the fluid was measured and, if necessary, put into the Warburg blender in order to obtain a more homogeneous solution. Aliquots suitably diluted were taken for analysis.

Blood loss during operation.

All swabs, towels etc. used during the operation were collected and soaked in cold water immediately after the conclusion of the operation. The /

The towels were rinsed thoroughly and wrung out at once and the washings preserved. The swabs were soaked over-night in a 5% solution of sodium hydroxide. The next day the swabs were wrung out and re-soaked in dilute 5% soda solution. The volume of the combined washings was measured and the nitrogen content of an aliquot of this fluid was determined. The nitrogen lost as blood at operation was then determined. Total blood nitrogen was determined on a specimen of blood withdrawn just before operation, so that it was possible to obtain an approximate value for the volume of blood lost at operation. Recovery experiments indicated that this method was accurate to 10%.

Stomach.

The portion of stomach resected was placed in a pyrex beaker, covered with A.R. sulphuric acid and left over-night. When the tissue had been completely dissolved by the acid, the solution was transferred to a volumetric flask and distilled water was added to make the volume up to 1,000 or 2,000 ml. This solution was diluted 1 in 5 and a nitrogen determination carried out on a 1 ml. aliquot.

ANALYTICAL METHODS.

Total nitrogen.

A micro modification of the Kjeldahl method was used. 1 ml. portions of the fluid for analysis, diluted to contain not more than 2 mg. nitrogen, were digested with 4 ml. of a modified Arnold Gunning digestion mixture (100 ml. A.R. sulphuric acid, 300 ml. A.R. phosphoric acid and 50 ml. of 5% w/v crystalline copper sulphate) until all charring had disappeared and then for a further 3 minutes, so that all the nitrogen present had been converted into ammonium salts. Ammonia was released by the action of excess 40% sodium hydroxide and, by means of steam distill--ation, carried over into N/70 sulphuric acid. A back titration with N/70 sodium hydroxide enabled the amount of ammonia liberated and thus the total nitrogen in the solution to be calculated. Using this method standard urea solutions gave recoveries of 98-100% and it was therefore decided not to use the method of digestion suggested by Chibnall, Rees and Williams (1943), which although more accurate, would have proved too time consuming for our purpose.

Plasma proteins./

Plasma proteins.

Plasma protein determinations were made by the micro-Kjeldahl technique, with magnesium sulphate as the fractionating agent. Popjak and McCarthey (1946) have shown that this method for the deter--mination of the albumin-globulin ratio was reliable, the values obtained being in close agreement with those given by electrophoresis.

Fibrinogen determinations were not made, so that all values given for globulin include fibrinogen.

Tungstic acid was used to precipitate the plasma proteins for the determinations of non-protein--nitrogen, which were then made by the above method.

Urea.

On account of the simplicity and the rapidity of the method, the urea concentrations of blood and urine were determined manometrically by the hypo--bromite reaction (Van Slyke 1929), though as Peters and Van Slyke (1932) (1) have pointed out, sodium hypobromite is a less specific agent than urease and errors of 1-4% may be expected.

Uric acid.

Uric acid was determined colorimetrically both in blood (Folin 1930) and urine (Benedict and Franke 1922) with a Duboresq colorimeter. The arsenophosphotungstic /

arsenophosphotungstic acid reagent used is specific for uric acid, and the blue colour produced is not normally affected by the other constituents of blood filtrates or urine.

Creatinine.

The method of Folin (1914) was used to determine creatinine in urine, the red colour produced by the Jaffe reaction being compared with that produced by standard solutions using a Hilger Biochem Absorptiometer. A modification of this method was used for the blood analysis (Folin and Wu 1919). There is some doubt as to the exact nature of the substances causing the Jaffe reaction in blood; Peters and Van Slyke (1932) (2) have presented evidence which suggests that the colour is, for the most part, produced by substances other than creatinine though for convenience it is customary to treat the results as if the red colour was wholly due to creatinine.

Amino Acid Nitrogen.

The method of Frame, Russel and Wilhemi (1943, 1944) was employed. This method depends upon the combination of amino nitrogen groups with β napthoquinone sulphonate in alkaline solution to form highly coloured compounds, orange-red in acid solution, which were determined colorimetrically using /

using a Gambrell Photoelectric Colorimeter No. 549 with a blue filter OB2 (maximum light transmission 480 mμ). It has the advantage over the nitrous acid and ninhydrin manometric and titrimetric procedures, in that it is suitable for determining 4-40 gamma amino N per sample, whereas they require at least 40 gamma, preferably more. Chinard and Van Slyke (1947) compared the photometric and ninhydrin manometric methods and considered that the former method gave satisfactory though in general slightly higher results (especially in cases of uraemia), due to the fact that β-napthoquinone is not specific for α amino nitrogen. Uric acid, the most concentrated of the interfering substances, normally found in blood yields a colour equivalent to 0.1 mg.% of amino N, when it is present in a concentration of 1.0 mg.%. In these studies no high uric acid values were encountered and therefore a correction for uric acid was not applied. Urea does not interfere with the colour reaction. Instead of the 0.2 ml. plasma suggested by Frame et al. (1943, 1944) 0.4 ml. were used and were made up to 10 ml.,after the addition of the decolourising reagents, in proportionate amounts, in order to get as strong a colour as possible; otherwise their procedure was followed.

This method was also used for determining the amino acid content of urine. The urine was diluted

1 /

1 in 25 and shaken gently with permutit for 5 minutes to remove any ammonia, which is an interfering substance in the reaction. The supernatant fluid was decanted and filtered and 1 ml. portions of this diluted urine were then treated in a manner similar to the plasma filtrate. Considerable individual variation in the daily excretion of amino acid nitrogen was encountered (0.1 - 1.4 g. per 24 hours), but the values for any particular individual were fairly constant. The daily figures given by the ninhydrin method (Van Slyke, McFayden and Hamilton 1943) correspond to 0.1 g. - 0.15 g. of amino N, whereas the nitrous acid method (Van Slyke and Kirk 1933) and the copper titration procedure of Albanese and Irby (1944) give higher results. The Formol titration method (Northrop 1926) gives figures averaging between 0.4 and 1,0g./day. The dependence of the results on the method employed is presumably due to differences in specificity for α amino nitrogen.

<u>Peptide Nitrogen</u>.

The term 'peptide nitrogen' was applied to the increase in amino acid nitrogen which resulted after hydrolysis of the urine. After treatment with permutit 10 ml. of the diluted urine were placed with 5 ml. of A.R. hydrochloric acid in a large pyrex tube. /

tube. The tube was fitted with a glass stopper and kept in a boiling water bath for at least 6 hours. The hydrochloric acid was removed by vacuum distillation. The first residue obtained was dissolved in water and the procedure repeated. The final residue was washed into a 20 ml. flask with distilled water and made up to the mark. The solution was filtered and 1 ml. aliquots taken for amino acid nitrogen analysis. In some instances it was found impossible to get a satisfactory reading on the colorimeter owing to the development of cloudi--ness in the solution. It was thought that this unpredictable difficulty was due to some interfering substance in the hydrolysed urine.

Sodium.

Sodium was estimated gravimetrically as the uranyl zinc sodium acetate salt, which weighs 67 times as much as the sodium in it. The method is specific for sodium, unless the solution in which the precipitate is formed contains more than 50 mg./ml. of potassium, which is unlikely in biological materials.

The urine received preliminary treatment with calcium hydroxide and mercuric chloride in order to remove phosphates and any protein which might be present; /

present; ashing was, therefore, unnecessary. (Butler and Tuthill 1931). Serum sodium estimations were performed according to the method described by Peters and Van Slyke (1932) (3). This method was also employed for stool estimations, using 1 ml. portions of the stool solution; the wet ashing was found to be more satisfactory than the more usual dry ashing procedure.

Chloride.

Chloride estimations were carried out on 1 ml. specimens of blood, plasma, urine or stool solution, using a modification of the method of Van Slyke and Sendroy (1923), whereby the chloride was precipitated using 5 ml. of N/29.25 silver nitrate in concentrated nitric acid solution, and the excess silver nitrate was titrated against N/29.25 potassium thyocyanate, with 5% ferric alum solution as the indicator

Potassium.

The platinic chloride microtitration method of Stohl and Bennet (1928) for determining potassium as the iodo-platinate described by Peters and Van Slyke (1932 (4) was used for serum. It is claimed that the accuracy of the method is such that with 0.4 mg. potassium (amount in 0.2 ml. of serum) the error /

error is within $\pm$ 2%.

The same method was applied to the estimations of urinary potassium as the usual dry ashing method gave inconsistent and low results. Recovery experiments with suitably diluted urine gave satis--factory results (95-100% recovery) but the high positive balances found before operation in well nourished patients caused doubts to be entertained regarding the validity of the method. A variety of methods involving the use of sodium cobaltinitrate, for gravimetric or colorimetric procedures, for the determination of urinary potassium were also tried, but were found unsatisfactory.

Analyses were also carried out on 10 ml. samples of stool suspension after dry-ashing, the residue being dissolved in distilled water and 4 N sulphuric acid and made up to 50 ml. of which 4 ml. were used for analysis.

Sulphur.

In urine the total sulphur was determined gravimetrically by precipitation as barium sulphate (Benedict 1909). 10 ml. portions of the stool solution were similarly treated, care being needed to avoid loss due to spurting while drying the solution.

Phosphorus. /

Phosphorus.

Inorganic phosphorus was determined colori-metrically in urine (96-99% total urinary phosphosphorus) and serum by measuring the intensity of the blue colour given with ammonium molybdate (Summer 1944). The urine was diluted so that the final solution for estimation contained between 0.01 - 0.2 mg. phosphorus (1/50 dilution being usually satisfactory). 10 ml. samples of the stool solution were ashed over-night in a muffle furnace, dissolved in a minimum of concentrated hydrochloric acid and then made up to 100 ml. with water. After diluting 1 in 10, 10 ml. portions were used for analysis, thus enabling the total phosphorous content of the stool to be calculated. The colour determin-ations were made with a Hilger absorptiometer (red filter OR.2).

Carbon Dioxide Combining Power.

The carbon dioxide combining power of blood was estimated manometrically using Van Slyke's apparatus. (Van Slyke and Cullen 1917).

Fat.

100 ml. aliquots of the stool solution were dried in a steam oven to constant weight. 2 g. of the /

the dried stool were then ground with silver sand and the mixture placed in a Soxhlet thimble and extracted with methylated ether for 24 hours. The ether was removed by evaporation and the weight of the fat residue determined.

Food analysis.

The figures for the food intake of the patients were supplied by the Dietetic Department. They were calculated from the Tables of McCance and Widdowson (1945). Periodically, duplicate samples of a day's food were analysed and good agreement was found to exist between the results obtained and those estimated from the Tables.

BLOOD VOLUME DETERMINATIONS.

Packed cell volume.

Blood was withdrawn by venipuncture and 3 ml. blood were placed in a Wintrobe tube. Some of this blood was transferred to a graduated haematocrit tube and spun at 2,500 revolutions per minute for 30 minutes, the remainder of the blood being used for red cell counts and haemoglobin estimations. No allowance was made for the plasma trapped in the red cells in the haematocrit determinations.

Plasma Volume.

The /

The method of Gibson and Evans (1937) was adopted . First, 20 ml. blood were withdrawn by venipuncture and then, through the same needle, a known amount of 0.24% T1824 dye was injected from a syringe calibrated for the 5 ml. mark. After periods of 10 and 30 minutes from the time of the injection of the dye 15 ml. of blood were withdrawn from a vein in the other arm. The blood specimens were allowed to clot. The clot was released and the specimens were centrifuged at approximately 1000 revolutions per minute for 15 minutes. The serum was removed using a Pasteur pipette and was again centrifuged for 15 minutes so as to remove any cells. The dye solution (0.24 %) was diluted 1/500. Immediate readings of the colour intensity of the diluted dye solution and the serum samples withdrawn at 0, 10 and 30 minutes were made with a Spekker Photoelectric Absorptiometer (red filter OR.2) with distilled water as the reference liquid in all cases. Cells of capacity 3.5 ml. were used and the reading obtained with the 10 minute serum sample was used in the calculation:

$$\text{Plasma volume} = \frac{500 \times (\text{calibrated vol. of syringe}) \times (\text{reading of diluted dye solution})}{(\text{Reading of serum at 10 mins.}) - (\text{Reading of serum at 0 mins.})}$$

Serum /

Serum was used for these determinations in preference to plasma as there was less likelihood of haemolysis occurring and because of the necessity of avoiding anticoagulants which might affect the thiocyanate space determinations which were carried out simultaneously.

Blood Volume.

The blood volume was calculated from a knowledge of the plasma volume and the packed cell volume using the following formula:-

$$\text{Blood Volume} = \frac{\text{Plasma Volume} \times 100}{(100 - \text{P.C.V.})}$$

Extracellular Volume (Thiocyanate Space).

The method of Bowler (1944) was used to determine the thiocyanate space. These estimations were usually made at the same time as plasma volume determinations and a known amount of 5% sodium thiocyanate solution was injected from a syringe, calibrated for the 10 ml. mark, after the injection of the T1824 solution. After precipitation of the serum proteins with 20% trichloracetic acid, ferric nitrate reagent was added to the filtrates and immediate readings of the red colour produced were made using a Spekker Photoelectric Absorptiometer (blue filter O.B.2) with water as the reference fluid.

Readings /

Readings were also made for the reagent solutions and for a 1/1000 dilution of the injected sodium thiocyanate solution. The thiocyanate space was calculated using the reading given by the filtrate of the serum sample taken at 30 minutes after the injection of the sodium thiocyanate.

$$\text{Thiocyanate space} = \frac{1{,}000 \times (\text{calibrated vol. of syringe}) \times (\text{reading of thiocyanate solution} - \text{reading of reagent blank})}{(\text{reading of serum at 30 min.s}) - \text{reading of serum at 0 mins.})}$$

The faint red colour given by the ferric thiocyanate, resulting from the treated serum, gave maximum readings on the Spekker scale of about .100. Variations of .002 in the denominator and numerator readings may cause differences in the calculated thiocyanate space of a 1000 ml.,regardless of any errors arising during the injection. Alterations in the thiocyanate space of less than 1000 ml. are, therefore, not significant.

BRITISH /

BRITISH PREPARATIONS OF PROTEIN HYDROLYSATE.

Pronutrin.

Pronutrin is a hydrolysate of casein, manufactured jointly by Atomised Food Products Ltd. and Herts. Pharmaceuticals Ltd. for oral administrat--ion. It is prepared by enzymic hydrolysis and consists of a mixture of amino acids and some of the simpler polypeptides. Chemical and animal experi--ments by the manufacturers have shown the product to be free from native protein, proteoses and other anaphylactogenic substances. It is supplied as a fine hydroscopic powder, pale cream in colour. It is soluble in water, and the pH of a 5% solution is approximately 5.5. In common with other protein hydrolysates it has a characteristic odour and taste that cannot be disguised, though most patients will tolerate them.

Analysis has shown Pronutrin to have the following composition:-

Total nitrogen	12%
Amino acid nitrogen	7%
Mineral matter	5%
Moisture	4%

The manufacturers claim that it contains adequate quantities /

quantities of all the essential amino acids, including 2 - 2.3% methionine.

Casydrol.

Casydrol is a mixture of amino acids and polypeptides derived from casein by digestion with pancreatic enzymes. It is manufactured by Genetosan Ltd. who claim that the product is apyrogenic, and free from depressor substances and anaphylactogens. It is supplied for parenteral administration in 500 ml. and 1000 ml. containers as a sterile solution which contains 5% of amino acids and 5% glucose, and is hypertonic. It contains the equivalent of 0.3% sodium chloride and has a pH of 6.5.

Analysis of Casydrol, employing the same procedures used for urine analysis, indicated the following composition:-

a) Total nitrogen	0.656 g. per 100 ml.
b) Amino acid nitrogen	0.33 " " "
c) Amino acid nitrogen after hydrolysis	0.49 " " "
d) Peptide nitrogen	0.16 " " "

The sealed containers could usually be kept for several months at room temperature without deterioration. Occasionally some of the amino acids precipitated /

precipitated out and, if attempts to re-dissolve them by heating the affected bottle in boiling water were unsuccessful, then the bottle was dis--carded.

MEDICAL CASES.

THE USE OF PROTEIN HYDROLYSATE IN THE TREATMENT OF PEPTIC ULCERS.

The use of large doses of protein hydrolysate for the treatment of patients suffering from peptic ulcers has been advocated by Co Tui et al. (1945). He claimed dramatic improvement in the clinical conditions of 27 patients, who were given, in 2-hourly feeds, a total of 300-400 g. Amigen and 300-400 g. dextri-maltose a day. It was, therefore, considered desirable to repeat, and if possible confirm, this work, using Pronutrin as thesource of protein hydrolysate.

The patients for this investigation were men selected from the Medical Out-Patients of the Royal Infirmary, Edinburgh. They all gave histories of epigastric pain, which was relieved by food and alkalies,and the diagnosis of duodenal ulcer had been confirmed by radiological examination prior to their admission to the metabolic ward. They refused an exclusive diet of Pronutrin and glucose and instead, received a diet of some 2,700 calories, made up of 300 g. carbohydrate, 85 g. fat and 65. g. protein, together with 110 g. Pronutrin. The hydrolysate was given as drinks between meals; some unsuccessful attempts were made to disguise its slightly offensive flavour, /

flavour, but, on the whole, most patients preferred to take it as a medicine made up into a cold water drink. Only one of the patients was able to tolerate large doses of Pronutrin without becoming nauseated. The food was prepared in the diet kitchen and a daily chart of each patient's food intake was kept by the dietician in charge.

In an endeavour to provide an objective method for assessing any improvement in the patient's condition, nitrogen balance studies were carried out. Daily estimations were made on all urine and faeces passed. The patients were weighed regularly and blood was taken for haematological and biochemical analysis. Chemical examination of the faeces included the Benzidine test.

<u>Case No. 1</u>. (J.C.) age - 37; occuptation, barman.

This patient, who had been recently demobilised from the Army as a battle instructor, remained in hospital for 3 weeks. On admission his faeces gave a positive result to the Benzidine test but, within a week a negative result was obtained. His blood chemistry was within normal limits (Hb. 105%, Alb. 3.63 g.%, Glob. 2.28g%, and N.P.N. 27.7 mg.%) Despite an average positive nitrogen balance for 3 weeks of 3-4 g. a day, he did not gain weight appreciably. Radiological examination prior to his discharge indicated that healing of the ulcer had occurred.

<u>Case No. 2</u>. /

<u>Case No. 2</u>. (J.T.) aged - 21; occupation, builders labourer.

This patient's faeces gave a positive result to the Benzidine test only for the first few days he was in hospital. His blood chemistry was within normal limits (Hb. 105%, Alb. 4.09 g.%, Glob. 2.33 g.%, N.P.N. 25 mg.%, and CO_2 combining power 66 vol.%). He maintained a positive nitrogen balance of about 3 g. a day throughout the period of the investigation, but did not gain weight. He made a normal recovery after 20 days in hospital.

<u>Case No. 3.</u> (A.M.) aged - 23; occupation, civil servant.

During his three weeks in hospital, no specimen of faeces gave a positive result to the Benzidine test. Gastric analysis on admission showed a maximum hydro--chloric acid concentration of 80 ml. of N/10 HCl/100ml. of gastric juice at 2 hours. His blood chemistry was within normal limits (Hb. 100%, Alb. 4.05 g.%, Glob. 1.88 G.%, and urea N. 16 mg.%). He gained $2\frac{1}{2}$ lb. in weight and maintained a small positive nitrogen balance of 2.45 g. a day throughout his 20 days hospitalisation. His clinical condition improved although radiological examination showed persistent deformity of the duodenal cap.

<u>Case No. 4.</u> (J.T.) aged - 19; occupation, electric welder.

On admission gastric analysis showed the presence of hyperacidity in this patient (maximum acid concentration - 100 ml. N/10 HCl / 100 ml. gastric juice) and specimens of faeces gave a positive result to the Benzidine test. No abnormality was apparent in his blood chemistry (Hb. 100%, Alb. 3.78 g.%, Glob. 2.33 g.%, N.P.N. 28 mg.% and CO_2 combining power 64 vol.%). Considerable variations in the daily urine nitrogen excretion were observed, for which no explanation could be given, since a urea clearance test gave a result of 99% of normal. The patient's symptoms disappeared during his 18 days stay in hospital, though he did not gain weight despite net positive nitrogen balance of over 2 g. a day. His appetite returned and he felt well on discharge.

Three /

Three weeks later, however, he was readmitted with a return of his symptoms and melaena (positive Benzidine test and haemoglobin 60%). He was again given a diet supplemented with 110 g. pronutrin and appeared to improve. Substitution of the pronutrin by an equal quantity of casein in its unhydrolysed form did not affect the nitrogen balance, though a loss of weight of 2 lb. occurred during this period. This weight was not regained upon the re-introduction of pronutrin to the diet, so that the loss may not necessarily have been due to the casein. An increase in the protein content of the diet to 92 g. a day with continued supplementation by pronutrin resulted in the patient gaining 4 lb. in weight in the last week of his 31 days stay in hospital.

<u>Case No. 5.</u> (J.B.) aged - 42; occupation, miner.

Gastric analysis on admission showed the presence of a mild state of hyperchlorhydria in this patient (maximum acid concentration - 70 ml. N/10 HCl / 100 ml. gastric juice). His blood chemistry suggested slight nutritional deficiency (Hb. 95%, Alb. 3.85 g.%, Glob. 1.60 g.%, and N.P.N. 40 mg.%) and he was, therefore, given a daily supplement of 160 g. pronutrin to his diet. Later this amount was increased to 240 g. per day, which was well tolerated by the patient who continued to have an appetite for his normal diet. Analysis showed that these large quantities of pronutrin were absorbed and apparently metabolised, being excreted for the most part as urea. He gained 4 lb. in weight on this high protein diet, although the expected positive nitrogen balance was not observed, possibly due to the fact that the patient had developed iridocyclitis in one eye. On his discharge after 7 weeks in hospital, he was symptom free, although radiological examination demonstrated the presence of a shallow ulcer.

<u>Case No. 6.</u> (J.A.) aged - 38; occupation, bus conductor.

During his 8 weeks in hospital this patient received different dietary regimes. For the first fortnight he was given a diet containing only 21 g. protein with as much pronutrin as he could take; unfortunately he could only manage 80 g. per day so that his average nitrogen balance was a negative one of /

of 1.92 g. per day, and he lost 2 lb. in weight. Upon increasing his protein intake to 7o g. per day and his pronutrin to 125 g. he maintained an average positive nitrogen balance 4.39 g. per day, but still did not gain weight. After 17 days the pronutrin was stopped and his whole protein intake increased to 165 g. a day. This resulted in increasing his daily average positive nitrogen balance to 9 g. and he gained 5 lb. in weight. He made slow clinical progress.

Observations.

The clinical impression gained during these investigations was that the rate of recovery of the patients had in no way been improved by the inclusion of protein hydrolysate in the diet. The patients were all mild cases of peptic ulcer, who would no doubt have responded to any treatment of rest and a high protein diet, so that in assessing the success of the treatment, the time taken for recovery was an important factor. It was considered that a diet containing similar quantities of protein could more pleasantly have been attained by using dried milk powder as the protein supplement, and the investig--ation was therefore not continued beyond the six cases reported. Browne (1946) has reported that a mixture of milk and milk powder gives as favourable results as protein hydrolysate in the treatment of patients with peptic ulcers. He considered that this was due to the qualitative improvement in the patient's /

TABLE 1.

Summary of Nitrogen Balance Studies on Patients with Peptic Ulcers.

Case No.	INTAKE Protein g.	Pronutrin g.	Fat g.	Carbo. g.	Cals.	Total N g.	Average Daily Stool N. g.	Average N Balance g/day	Change of Weight lbs.	No. of days treatment
1	56	125	70	240	2314	23.96	1.57	+3.43	+1.4	21
2	65	110	87	314	2739	23.60	1.22	+4.57	+0.5	20
3	65	110	87	314	2739	23.60	1.01	+2.45	+2.5	20
4 (i)	57	120	67	235	2251	23.52	1.26)	+2.06)	nil	13)
							(2.13	(2.35		(18
	102	120	121	330	3297	30.72	2.57)	+3.08)		5)
(ii)	65	110	87	314	2739	23.60	1.36	+3.75	+4.4	25
5	66	160	70	337	2881	29.76	1.19)	-0.09)	+2)	5
							(1.20	(-0.11	(+4	
	66	240	70	337	3202	39.36	1.24)	-0.12)	+2)	12
6	21	80				12.96	1.06	-1.92	-2	14
	70	125	Not recorded			26.20	1.51	+4.39	+0.25	17
	165					26.40	1.57	+9.24	+5	19

patient's diet.

No evidence has been obtained which would indicate that protein absorption is impaired in cases of peptic ulcer, for although isolated specimens of faeces did contain relatively large amounts of nitrogen, these usually followed a period of constip--ation and the average daily faecal nitrogen was not high. No differences in the ability of the patients to absorb whole protein or protein hydrolysate were observed. The fact that the ratio of urea nitrogen to total nitrogen was within normal limits suggests that the protein hydrolysate was normally metabolised. Over the period of the investigation, positive nitrogen balances were found in 5 out of the 6 patients, but weight gains, if any, were in all cases small. Kennamore (1948) in a similar study found that, despite positive balances of as much as 12 g. of nitrogen a day, the body weight of his patients who were not mal--nourished also remained remarkably constant. (Table 1).

No significant changes in plasma protein values were found, so that the fate of the stored nitrogen and the extent of its utilisation remains unknown. It was observed with one patient (Case No. 6) that no appreciable weight was gained, despite a high nitrogen and /

and caloric intake, until the Pronutrin in the diet had been exchanged for whole protein. There may, therefore, be some unknown factor essential for tissue protein production in the human adult, which is lacking in an enzymic digest of casein despite animal experiments to the contrary (Cox 1939).

ANTACID PROPERTIES OF PRONUTRIN.

Co Tui et al. (1945) suggested that the improved condition of their patients suffering from peptic ulcer might have been due to the antacid properties of the protein hydrolysate, which are apparent "in vitro." In experiments on 2 patients, who were given 3 successive feeds of 25 g. Amigen and 37 g. dextri-maltose (pH5.39) at hourly intervals, they showed that the production of free acid could be prevented for 1-2 hours, but that after that free acid appeared in the gastric juice. In a patient with low acidity the feeding of a mixture containing 50 g. Amigen and 58.6 dextri-maltose, did not result in the production of free acid for $2\frac{3}{4}$ hours.

Levy (1942) had shown that 300 ml. of a 10% Amigen solution given to 18 fasting students (with average fasting levels of 20.7 ml.N/10 HCl/100 ml. gastric juice) prevented the production of any free acid for 30 minutes in all the students, and in 13 out of 18 students for 50 minutes. After 60 minutes, however, the average free acid content was 24.2 ml. N/10 HCl/100 ml. gastric juice. He concluded that a solution of amino acids is of value as an antacid for a significant interval of time.

Experimental. /

TABLE 2.

A comparison of the Antacid Properties of Pronutrin and Milk Proteins.

Subject	Test Meal	Ml. of N/10 HCl per 100 ml. Gastric juice.														
		0 min.	10 min.	20 min.	30 min.	40 min.	50 min.	60 min.	70 min.	80 min.	90 min.	100 min.	110 min.	120 min.	130 min.	140 min.
A	Pronutrin & Sucrose	2	nil	nil	nil	3	12	24	31	34	26	25	22	-	-	-
	Fresh milk	28	nil	nil	nil	nil	nil	nil	1	2	7	6	18	28	46	38
	Reconstit. Dried milk	28	nil	nil	nil	nil	nil	5	20	16	37	36	20	-	-	-
	Pronutrin & Butter & Sucrose	6	nil	nil	nil	nil	nil	2	4	6	14	34	34	24	-	-
B	Pronutrin & Sucrose	58	nil	nil	2	5	36	58	70	80	75	70	-	-	-	-
	Fresh milk	73	nil	nil	nil	1	8	12	28	36	52	70	75	75	-	-
	Reconstit. Dried milk	34	nil	nil	1	3	12	10	6	-	-	-	-	-	-	-
	Pronutrin & Butter & Sucrose	nil	nil	nil	nil	nil	4	23	32	34	37	37	-	-	-	-

Experimental.

A comparison of the antacid properties of a solution of Pronutrin with those of fresh milk and a solution of reconstituted dried skimmed milk powder was made. Solutions of the following substances were prepared to contain the sugar, nitrogen and water equivalent of ½ pint of fresh milk:

a) milk

b) dried skimmed milk powder

c) pronutrin and sucrose

d) pronutrin, sucrose and butter (equivalent in weight to the fat content of ½ pint milk)

They were given to 2 young fasting adults on 4 successive days. Samples of the gastric contents were withdrawn at 10 minute intervals by means of a Ryle's tube, and aliquots were titrated against N/10 sodium hydroxide solution using Topfer's reagent as an indicator (Table 2).

The experiments, though admittedly limited in number, gave no indication that the antacid properties of Pronutrin are in any way superior to those of whole milk proteins. In both subjects free acid re--appeared in the gastric contents at a shorter time interval after the Pronutrin test meal than after the whole milk test meal, though there were no significant differences /

TABLE 3.

Pronutrin as a Gastric Stimulant.

		Mls. of N/10 HCl per 100ml. Gastric juice						
Patient	Test meal.	0 min.	30 min.	60 min.	90 min.	120 min.	150 min.	180 min.
						Histamine		
C	Gruel	16	nil	4	4	84	80	-
	Pronutrin	24	4	8	8	32	64	90
D	Gruel	4	-	-	-	-	-	-
	Pronutrin	16	16	60	60	56	28	20

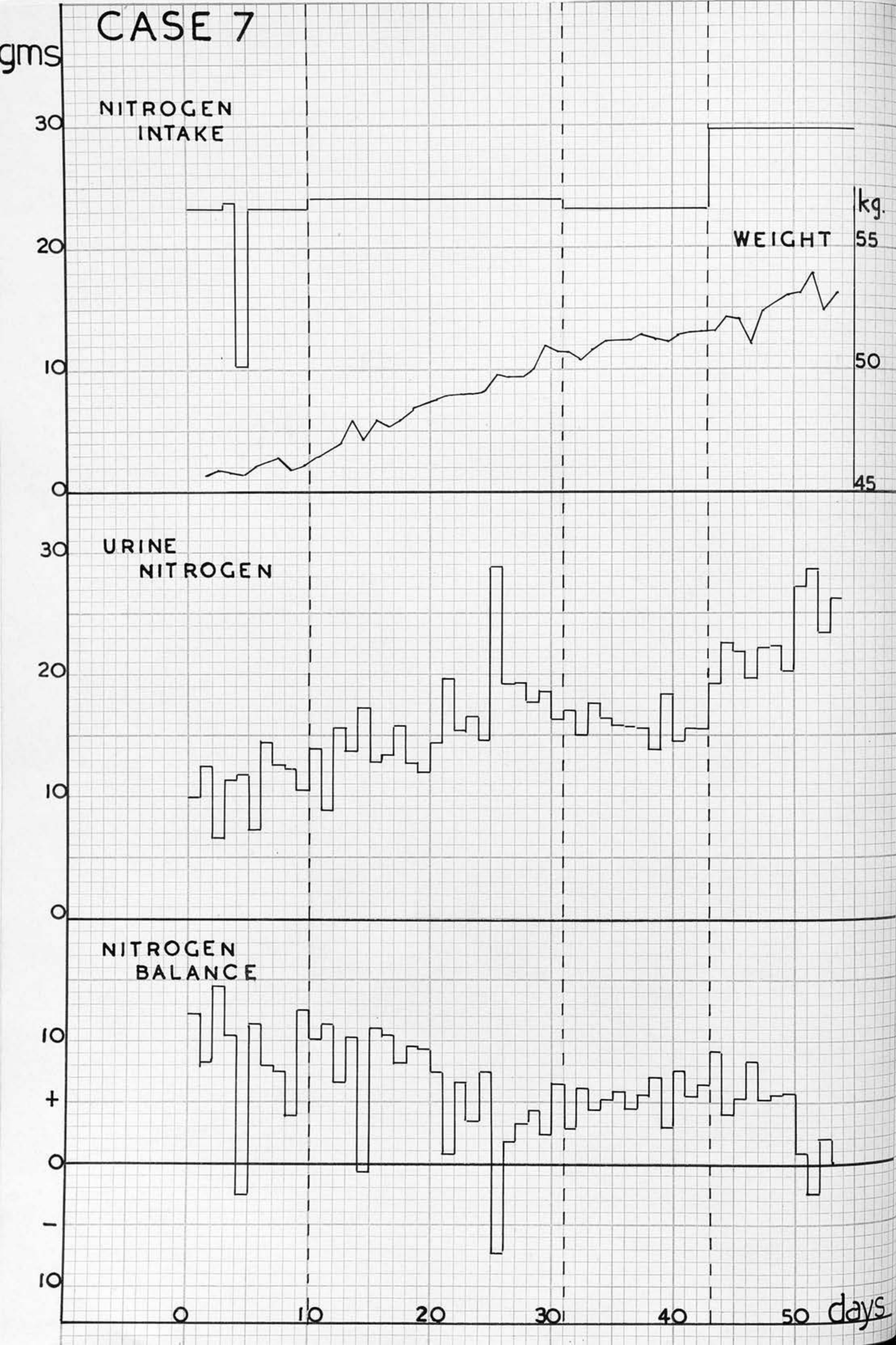
differences in the maximum acid concentration eventually reached. The addition of fat in the form of butter to the pronutrin and sugar solution prolong--ed its antacid effect by slowing down the rate of absorption of the pronutrin. Although for a short period of time pronutrin behaved as an antacid, it also acts as a stimulant of gastric secretion. (Table 2).

<u>The Action of Pronutrin as a Stimulant of Gastric Secretion</u>.

This action of pronutrin has been studied in a number of patients by giving them 20 g. pronutrin in 200 ml. of water as a test meal, and then comparing the acid production with that obtained as the result of a normal test meal. These results have shown that pronutrin causes a production of hydrochloric acid nearly as great as that produced by histamine and over as long a time. In several cases of apparent achlor--hydria, but not those that are histamine resistant, it has been found possible to stimulate acid secretion by means of a pronutrin test meal (Table 3). It is possible, therefore that protein hydrolysate preparations may have a therapeutic value as stimul--ants of gastric secretion.

These findings are in agreement with those of Rossien /

Rossien (1947) who compared the effect of a modified Edwald meal with that of graduated doses of protein hydrolysate (M.R.T.) on the gastric secretion of 56 patients. He showed that at the end of 1 hour, 12 out of 56 patients had more free acid in their gastric juice when given protein hydrolysate as a test meal, than with the modified Edwald meal, while 37 of the patients had no free acid. After 90 minutes, regard-less of the dose, more than 5 out of 7 in each protein hydrolysate group had a return of free acid, and 38 out of 56 had a higher free acid figure than at the 1 hour period after the modified Edwald meal. Rossien also suggested that, whereas the primary effect of a dose of protein hydrolysate solution is an antacid one, it later acts as a stimulant of gastric secretion.


CASE 7
gms
NITROGEN
INTAKE
30
20
10
0
kg.
WEIGHT
55
50
45
URINE
NITROGEN
30
20
10
0
NITROGEN
BALANCE
10
+
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−
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0
10
20
30
40
50
days

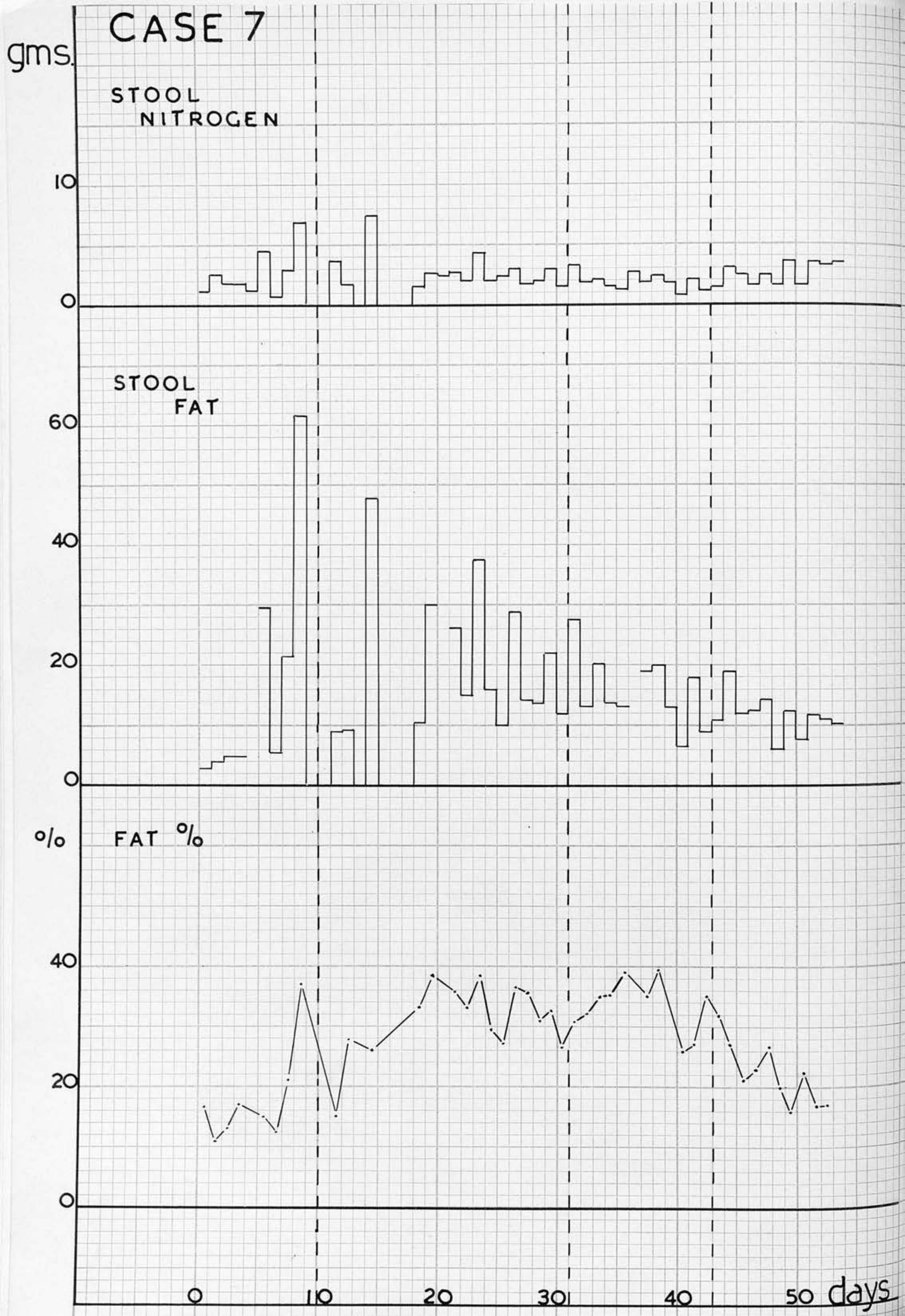
THE USE OF PRONUTRIN IN THE TREATMENT OF STEATORRHOEA.

The faeces of patients suffering from stearorrhoea are characterised by a high fat and a high nitrogen content. In case the high nitrogen content was due to impaired digestion of protein, it was suggested that the administration of protein hydrolysates might be of benefit. Nitrogen balance studies were, therefore, made in two such cases, together with daily estimations of stool nitrogen and fat. The results obtained when the patient was taking a high fat and high protein diet were compared with those obtained when this diet was supplemented with Pronutrin in cold water taken between meals.

<u>Case No. 7</u> (M.McB.) Aged 37; occupation, domestic servant.
Diagnosis - steatorrhoea, secondary to tuberculous peritonitis.

For the first 10 days of the investigation, this woman was given a diet of 145 g. protein and only 36 g. fat and initially was able to keep her fat excretion within normal limits. She did not gain weight. Her daily intake was then increased to 150 g. protein and 80 g. fat for 21 days and her inability to utilise the fat of her diet became apparent with a rise in both the daily fat excretion to 16.8 g. and the percentage of fat in the faeces to 30.8%. Of the fat excreted, 58.3% was split and 41.7% unsplit. She continued to maintain a positive nitrogen balance and her weight increased.

The /



CASE 7
gms.
STOOL
NITROGEN
10
0
STOOL
FAT
60
40
20
0
%
FAT %
40
20
0
0
10
20
30
40
50
days

The inclusion of 55 g. Pronutrin in the patient's diet resulted in the average fat excretion falling to 11.84 g. per day but the percentage of fat in the faeces remained high. After 12 days on this regime, the Pronutrin intake was increased to 110 g. daily and an average fat excretion of 10.92 g. per day, with 21.55% fat in the faeces was recorded. The average daily nitrogen loss in the stools rose from 1.79 g. to 2.90 g. Her weight continued to increase and on her discharge from hospital after 54 days she had gained a total of 16 lb. Her plasma proteins had risen from a total of 4.53 g. %. to 5.18 g.%.

Case No. 8 (A.B.) Aged 34; occupation, University lecturer.
Diagnosis - idiopathic steatorrhoea.

The addition of 110 g. Pronutrin to this patient's daily intake of 114 g. protein and 94 g. fat had no apparent beneficial effect on either the fat utilisation or the protein absorption. During the Pronutrin regime the average faecal nitrogen excretion rose from 3.99 g. per day during the control period to 5.81 g. per day, though there was a slight improvement in the percentage absorption of nitrogen from the diet on the higher intake. The average fat content of the faeces rose from 33.1 g. per day to 51.1 g. per day, while the percentage of fat in the faeces increased from 35.8% to 43.7%. The higher average figures obtained during the Pronutrin regime are partly due to the fact that on two successive days whole casein was substituted for Pronutrin and this was so badly tolerated by the patient that in 24 hours he passed faeces which contained a total of 12.6 g. nitrogen and 121 g. fat. This also accounts for the loss in weight of the 3 lb. that had been gained while on the diet, so that over the period of the investigation there was no net gain in weight.

(Table 4).

Pronutrin did not, therefore, appear to have any specific beneficial effect on the malabsorption syndrome as such, though it did provide a means of increasing the protein content of the diet and the amount /

TABLE 4.

SUMMARY OF RESULTS FOR 2 CASES OF STEATORRHOEA.

Case No.	No. of days.	Protein g.	Pronutrin g.	Total N. g.	Fat g.	Average faecal N g/day	Average daily fat excretion g.	Average % of fat in faeces	% loss of Food N in faeces.
7	10	145	-	23.20	36	2.06	13.56	17.89	8.9
	21	150	-	24.00	80	2.15	16.80	30.89	9.0
	12	103	55	23.98	81	1.79	11.84	32.02	7.5
	11	103	110	29.68	81	2.90	10.92	21.55	9.8
8	4	114	-	18.22	94	3.99	33.1	35.8	21.5
	15	110	110	30.80	93	5.81	51.1	43.7	18.9

amount of protein absorbed without the addition of further fat. The value of high protein diets to these patients is well-known and Pronutrin may provide an easy means of providing the required level of intake.

THE USE OF PRONUTRIN IN THE TREATMENT OF ANOREXIA NERVOSA.

Pronutrin was given to 2 cases of anorexia nervosa as a means of increasing their nitrogen intake. It was hoped that the protein hydrolysate would be utilised by the patient and that, with an improvement in the patient's general condition, the appetite would be stimulated to larger intakes of normal food.

Case No. 9 (I.D.) Aged 20; occupation, market gardener.

The addition of 60 g. Pronutrin a day to the diet of this woman, who had a fairly good appetite andhad an averate daily intake of 77 g. nitrogen and 2000 calories, had no apparent beneficial effect on her nitrogen retention. Her weight remained constant at 6 st. 5 lb. during the 9 days she was taking Pronutrin.

Case No. 10 (M.S.) Aged 31; occupation, teacher.

This patient received 100 g. Pronutrin a day, in addition to whatever other food she would take. The Pronutrin, however, had an adverse effect on her appetite, so that her previous protein intake of about 40 g. a day dropped to 20 g. a day. Despite a daily nitrogen intake of 15.2 g. during the 7 days that she was on this diet, she remained in slight negative nitrogen balance and did not gain weight. This was possibly due to the low caloric intake (average 972 cals. per day). The ratio of urea nitrogen to total nitrogen in the urine suggested that the Pronutrin had been metabolised.

Treatment /

Treatment with 20 mg. testesterone daily resulted in some gain in weight which was later shown to be due to water retention. Intravenous feeding with Casydrol was then attempted but after 2 days, thrombosis of the vein occurred, and this method of feeding had to be abandoned before its value could be assessed.

Neither of these patients had given any indicat--ations that their clinical symptoms were associated with malabsorption so that it was perhaps not surpris--ing that the use of protein hydrolysate appeared to have no specific beneficial action, beyond increasing the nitrogen intake of the patient. For cases where feeding by intubation becomes necessary Pronutrin may well be of value as a means of providing a high nitrogen intake in a concentrated form. No suitable case, however, was available for investigation of this possibility.

THE USE OF CASYDROL IN MEDICAL CASES.

Patients who are unable, or unwilling, to take food by mouth, and those who are unable to utilise the whole protein of a normal diet might, from theoretical consideration, benefit from parenteral protein feeding. Casydrol was therefore given to the following medical cases to see if it would be of any help to them.

Case No. 11 (N.C.) Aged 32; occupation, farm worker.
Diagnosis - hypoproteinemia.

This patient had been in the metabolic ward on a high protein intake for several weeks prior to this investigation, but no improvement in his plasma protein level (alb. 2.6 g.%; glob. 2.2 g.%) or general condition had been obtained. On a daily intake of 125 g. protein and 2,916 calories, he remained in slight positive nitrogen balance but did not gain weight. His average faecal nitrogen excretion was 2.39 g. per day, which represents about 10 g. protein per day above the "expected" wastage. In addition to his normal diet he was then given 1,080 ml. Casydrol, which was administered at a slow rate. Blood samples were taken and urine voided at hourly intervals on the first day of the infusion. Two hours after its commencement the plasma amino acid level had risen from 5.6 mg.% to 6.9%, but by the time the infusion was completed, it had fallen to 6.1 mg.% and an hour later was back to a normal level. Urine analysis showed that of the amino acid nitrogen not metabolised the highest proportion was excreted 9 hours after the commencement of the infusion. (Appendix).

The addition of Casydrol to the normal diet was repeated on the following three days, on the second of /

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of which only 150 ml. was administered, while on the fourth day a rigor occurred at the conclusion of the infusion of 1,080 ml. Casydrol. A plasma amino acid nitrogen level of 7.8 mg.% was recorded. In all, the patient received 2,390 ml. in 4 days, from which approximately 60% of the amino acid nitrogen and 53% of the peptide nitrogen appeared to be metabolised. The effect on the patient's nitrogen retention, weight and plasma protein concentration was not significant, so that it was unfortunate that it was not possible to continue with the infusions for a longer period of time.

Case No. 12 (W. H.) Aged 60; occupation, retired.
Diagnosis - chronic starvation.

This patient was admitted to a nursing home after a long period of self-imposed starvation. He had lost his appetite and Casydrol was prescribed as a means of giving the man some form of protein intake. He was given 1,620 ml., 540 ml. and 540 ml. respectively on three successive days. Circumstances did not permit complete nitrogen balance studies to be made but urine analysis indicated that approximately 82% of the amino acid nitrogen administered was metabolised. The treatment appeared to have a beneficial effect on both the man's general clinical condition and his appetite, so that he was afterwards able to start taking a normal diet.

Case No. 13 (W.M.) Aged 75; occupation, retired general labourer.
Diagnosis - inoperable carcinoma of oesophagus.

This patient was admitted in a state of severe dehydration and unable to take food by mouth. He was given on three successive days 2,160 ml. Casydrol parenterally. The infusions corrected his dehydrat--ion and appeared to be of temporary benefit to his general condition. During this period he remained in positive nitrogen balance. Thereafter, the patient became very drowsy and the infusions had to be stopped for varying periods of time, so that a constant protein and caloric intake became impossible and a negative nitrogen balance resulted. No toxic symptoms appeared to result from the infusions of Casydrol /

Casydrol and his plasma amino acid nitrogen level remained at approximately 4.9 mg.% except for a small temporary rise, in the sample of blood taken 3 hours after the commencement of the infusion, to 6.6 mg.%. The infusions were continued for 10 days during which time approximately 88% of the amino acid nitrogen and 36% of the peptide nitrogen administered was metabolised. A negative nitrogen balance of 4.26 g. nitrogen was recorded over the period of the investigation. It was not expected that this method of feeding would have any effect on the final result of his fatal illness but it did make the patient more comfortable.

SURGICAL CASES.

Clinical Procedure.

The patients were selected male cases admitted to one of the general surgical wards of the Royal Infirmary, Edinburgh. The majority suffered from chronic duodenal ulcers. They were treated surgic-ally by partial gastrectomy. During their stay in hospital they were all under the special supervision of a surgeon who was responsible for the organisation in the ward, but who did not necessarily perform the operations. No special nursing arrangements were made for these patients.

On admission, the patient was interviewed by a dietitian, who arranged for a suitable high protein diet to be supplied from the diet kitchen. Any uneaten food was returned to the diet kitchen so that it might be weighed, and a record of the food actually consumed kept. After a day on the special diet, all specimens of urine (voided direct into a bottle kept by the patient's bedside), faeces, vomitus and gastric aspirations were collected for 24 hour periods and sent to the laboratory each morning for analysis. Food when required in the post-operative period was again supplied from the diet kitchen, and the intake was gradually increased so that, in general, an

intake /

intake of 80 g. protein and 2,000 calories had been reached in 6 days.

Specimens of all intravenous fluids administered were taken for analysis, and the volume of fluid actually received by the patient was determined. Most Patients were given 2 pints blood, 800 ml. 0.9% saline, and 1200 ml.5% glucose on the day of operation; on the next day they received 800 ml. 0.9% saline and 800 ml. 5% glucose, and on the following day 400 ml. 0.9% saline and 400 ml.5% glucose.

The blood loss at operation was estimated by determining the nitrogen content of the lost blood as described in the section on chemical procedure. The nitrogen content of the stomach resected was also estimated and recorded, but neither of these sources of nitrogen loss was included in the nitrogen balance calculations, nor was the nitrogen of the transfused blood included, as its metabolism is still not clear--ly understood.

Blood samples were taken by venepuncture as required. The number taken during the post--operative period was largely conditioned by the patients' willingness to co-operate, so that it was impossible to adhere to any strict routine. Estimat--ions of faecal nitrogen excretion were made, and the results/

results recorded as if the faecal excretion of a particular day was associated with that day's intake. It is realised that this assumption is incorrect, but preliminary experiments with markers were unsatis-factory and the spreading of values for faecal nitrogen over the whole period of the investigation seemed also undesirable, especially as the food in-take was variable.

When possible, the nitrogen balance studies were begun a week before operation, and continued for at least a fortnight after operation. A patient was considered to be in nitrogen equilibrium if a negative nitrogen balance of not more than 1 g. per day was recorded, since this was within the limits of probable experimental error.

Daily records of the patients temperature, pulse and fluid intake were kept by the ward staff. The patients were weighed and measured on admission, and in the majority of cases were weighed daily during their stay in hospital, though in one of the wards, owing to lack of facilities, this was not practicable in the immediate post-operative period.

CHANGES IN NITROGEN METABOLISM FOLLOWING SURGICAL TRAUMA.

The metabolic changes associated with trauma in fracture cases have been carefully studied by Cuthbert--son (1932, 1936). He has shown that increased protein catabolism occurs and that the resulting increased nitrogen excretion is due almost entirely to increases in urea nitrogen, while proportional increases in sulphur excretion are due mainly to increases in inorganic sulphur (Cuthbertson 1931). He could find no obvious relationship between the degree of trauma and the catabolic response. Howard (1944, 1945) obtained similar results in the United States, when he showed that for 6 fracture cases the maximum negative nitrogen balance was obtained on the 7th day after the fracture, and that the average duration of the negative balance was 35.6 days on a constant intake of 11 $\pm$ 2 g. nitrogen and 1,750 $\pm$ 400 calories. The total nitrogen loss was 220 g., which is equivalent to a loss of 15 lb. of muscle tissue.

This catabolic response to injury has been studied after other types of trauma in which it has been shown to conform to a similar pattern. Studies of /

of the "Adaptation Syndrome" of Selye (1946) and the "Maladie Post-Operatoire" of Lambret (1937) suggest that the response is independent of the type of injury.

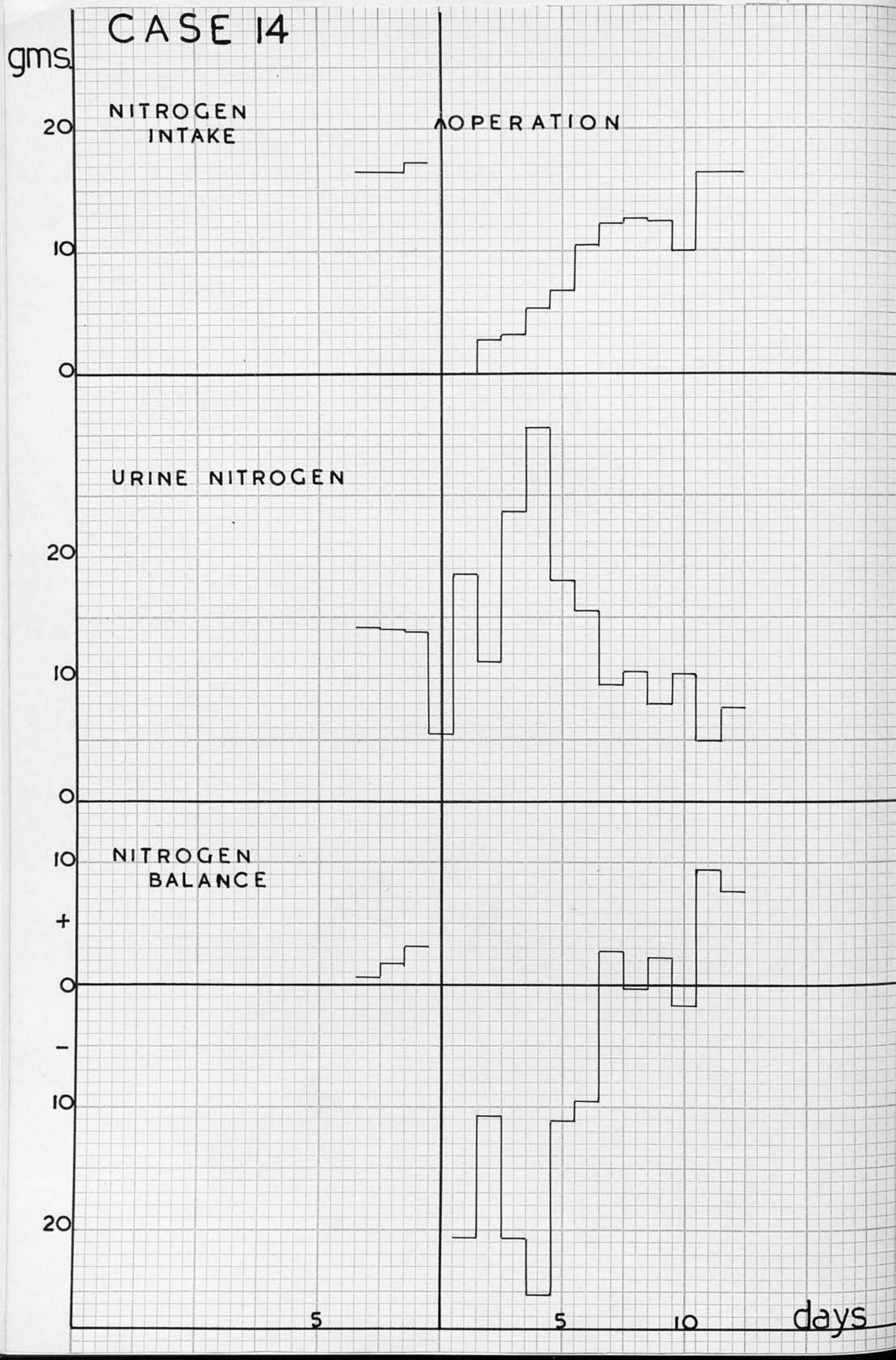
Brunschwig (1942) carried out nitrogen balance studies on 41 patients subjected to various operations for the 10 days following operation. He found no correlation between the age, sex, type of anaesthesia, or the presence or absence of neoplasm, and the extent of the nitrogen loss, the major portion of which occurred during the first 5 post-operative days. Grossman et al. (1945) studied the changes in nitrogen metabolism following such acute infections as meningitis, pneumonia, scarlet fever and in upper respiratory infections, chronic osteomyelitis etc., and also following appendicectomy or herniorraphy, and found that the severe nitrogen loss which occurred in all cases bore some relationship to the severity of the disease, but that they were very variable and frequently persisted after the symptoms had disappear--ed. Co Tui (1944) has reported that on a normal ward regime, 8 under nourished patients convalescing from a partial gastrectomy lost from 7-12 g. nitrogen in the immediate post-operative period. Numerous metabolic studies have been made on patients suffering from /

from burns; these have been reviewed by Abbot (1946). Comprehensive reviews on the metabolic changes following injury have been written by Himsworth (1946), Cuthbertson (1942, 1944, 1948) and Beattie (1947).

That protein catabolism does result from any surgical procedure is now an accepted fact, but before considering the factors which may influence the extent of the tissue breakdown, it was necessary first of all to obtain as clear a picture as possible of exactly what did occur after one particular type of trauma, under as uniform conditions as possible. The operation of partial gastrectomy for chronic duodenal ulcers was chosen for this investigation, and in the following section of this thesis the results of nitrogen balance studies on 7 such patients are discussed.

It has been shown in rats that the amount of nitrogen loss after injury is dependent on the level of the protein intake during the pre-traumatic period (Cuthbertson et al. 1939, Munro and Chalmers 1945). It was, therefore, considered advisable to give similar pre-operative protein intakes to all the patients for as long a period as possible. The value of high protein diets for surgical patients is now /

now generally accepted and so, intakes of some 90 g. protein and 2,500 calories were given.



CASE 14
gms.
NITROGEN INTAKE
OPERATION
20
10
0
URINE NITROGEN
20
10
0
NITROGEN BALANCE
10
+
0
-
10
20
5
5
10
days

CONTROL SERIES OF PATIENTS ON WHOM THE OPERATION OF PARTIAL GASTRECTOMY WAS PERFORMED.

Case No. 14 (J.McN.) Aged 35; occupation, tram-driver.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient was admitted 5 days before his operation and given a diet of 104 g. protein and 2,578 calories, on which he maintained a slight positive nitrogen balance. At operation he received a transfusion of 910 ml. blood, which just replaced his blood loss. No food was taken on the day following operation, but after that his intake was gradually built up, so that on the 7th day it consisted of 80 g. protein and 1,993 calories and he was in positive nitrogen balance. A net negative nitrogen balance of 97.96 g. nitrogen was recorded for the 6 days following the operation, and the maximum nitrogen loss occurred on the 4th day, when the urine nitrogen rose to 25.18 g. nitrogen. He was discharged 14 days after his operation, having lost considerable weight.

Case No. 15. (W.A.L.) Aged 65; occupation, fisherman.
Diagnosis - chronic duodenal ulcer
Operation - partial gastrectomy.

After only 4 days in hospital the operation was performed and the next day feeding was begun and his intake gradually increased to 60 g. protein and 1,685 calories in 6 days. The blood transfusions given at operation more than replaced the blood loss. His food intake remained at the same level for 6 days, during which time an average negative nitrogen balance of 5.1 g. nitrogen per day was recorded. It was not until 11 days after the operation, when the daily intake rose to 70 g. protein, that positive nitrogen balance was obtained. The maximum nitrogen loss of 17.26 g. nitrogen occurred on the first post-operative day as the result of a loss of 13 g. nitrogen in the urine, and 4.26 g. nitrogen in the gastric aspirations. At /

At no time did the urine nitrogen rise above 16.19 g. nitrogen (4th day) and it remained at a fairly constant level throughout the period of the investi--gation. He lost 9 lb. in weight.

Case No. 16 (W.L.) Aged 33; occupation, miner.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

After 4 days on an intake of 81 g. protein and 2,305 calories operation was performed on this patient, who received an adequate blood transfusion. Feeding was begun the next day, and on the 6th day his intake was up to 67 g. protein and 1,357 calories; he was then in positive nitrogen balance. His urine nitrogen excretion never rose above 12.36 g. nitrogen on the 3rd day, and on the whole remained remarkably constant. His net negative nitrogen balance for the first 6 post-operative days was only 38.99 g. nitrogen despite his body temperature being raised to 100°F. during that period. There was thus little evidence of a catabolic phase having occurred. His intake on discharge had not risen above 75 g. protein and 2,000 calories so that he was only just in nitrogen equilibrium. He lost 10 lb. in weight in 14 days, which was unexpected in view of his small nitrogen loss.

Case No. 17 (W.P.) Aged 41; occupation, rope worker.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

The blood transfusion given to this patient at operation was not sufficient to replace the blood lost. A maximum urine excretion of 21.2 g. nitrogen was recorded on the day after the operation. The urine for the next day was unfortunately lost so that it was not possible to determine the net nitrogen losses. Feeding was begun on the day after operation and in 5 days an intake of 87 g. protein and 1,911 calories had been obtained, and by the 6th day, the patient was almost in nitrogen equilibrium.

Three days later a second catabolic phase occurred as a result of a septic thrombosis of the patient's leg. In addition to the increased urea nitrogen /

nitrogen excretion there was an increase in the amount of urine amino acid nitrogen excreted, although the peptide nitrogen remained unchanged. After 4 days the condition of the leg had improved and the patient was once again in nitrogen equilibrium. He was discharged 20 days after his operation.

Case No. 18 (T.B.) Aged 36; occupation, -
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

Operation was performed on this patient after he had received a diet of 105 g. protein and 2,570 calories for 7 days and had remained in nitrogen equilibrium. A blood transfusion of 2 pints of blood was not quite sufficient to replace his blood loss. The next day he was given an infusion of 620 ml. Casydrol. Owing to a reaction, probably due to the infusion being given at too fast a rate, this infusion was discontinued and 2 days later oral feeding was commenced. By the 9th day after operation his diet only supplied 60 g. protein and 1,675 calories so that the patient was barely in nitrogen equilibrium. His maximum urine nitrogen excretion of 19.43 g. nitrogen occurred on the 3rd day after operation and the net negative nitrogen balance for the 6 days was 92.44 g. nitrogen.

Case No. 19 (J.T.) Aged 35; occupation, linoleum worker.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

After a week in hospital on an intake of 70 g. protein and 1,800 calories which maintained nitrogen equilibrium, the operation was performed. No food was given until the 3rd day after operation. A positive nitrogen balance was recorded for the 6th day on an intake of 67 g. protein and 1,838 calories. A maximum urine excretion of 17.02 g. nitrogen occurred on the day after operation, and a net negative balance of 57.11 g. nitrogen was recorded for the first six days after operation. He only lost 3 lb. in weight.

Case No. 20 /

TABLE 5.

Summary of Results for Partial Gastrectomy Patients.

Case No.	Pre-op. N. Balance g/day	Duration of Neg. N. Balance / days	Pr. Intake for N Equilibrium g.	Pr. Intake at 6th day g.	Net Neg. Balance for 6 days g.	Loss in weight lb.	Day of max. urine N post-op.
14	+1.81	6	80	80	97.96	?	4
15	-0.60	10	79	60	60.24	9	1
16	+2.03	6	67	67	38.99	10	3
17	-0.12	5	76	65	-	not record--ed	1
18	+0.88	9	66	17	92.44	10.5	3
19	+0.14	6	67	67	57.11	3	1
20	+6.05	6	65	65	78.46	?	1
Average	-	6.85	71	-	70.70	8.1	2

Case No. 20 (A.B.) Aged 32; occupation, process worker.
Diagnosis - duodenal ulcer.
Operation - partial gastrectomy.

An average positive nitrogen balance of 6.05 g. nitrogen was observed for 4 days with this patient, who was receiving an intake of 116 g. protein and 2,832 calories. His blood requirements at operation were adequately met by the transfusion of 1 pint of blood. Oral feeding was begun on the 3rd day after operation, and by the 6th day his intake had risen to 65 g. protein and 1,599 calories, and he was almost in nitrogen equilibrium. His maximum urine nitrogen excretion of 16.02 g. nitrogen was on the day after operation. His net nitrogen loss of 78.46 g. nitrogen occurred during the first 6 post-operative days.

(Table 5).

The results of nitrogen balance studies made on 7 cases on whom partial gastrectomy was performed are summarised in Table 5. The day on which the maximum urine nitrogen excretion was recorded varied for the different patients. The results suggest that it is impossible to obtain nitrogen equilibrium in these patients after operation until an intake of at least 65 g. protein and approximately 2,000 calories has been attained. The fact that nitrogen losses after operation are in part due to a period of limited food intake has been emphasised by many workers including Brunschwig (1942), Elman (1944), Riegal (1945, 1947) and Werner (1947). The variations in the total negative nitrogen balances recorded /

recorded indicate that feeding is not the only factor involved, though it is a limiting factor as can be seen by considering the following case:-

Case No. 21 (J.K.) Aged 60. Diagnosis - chronic duodenal ulcer.
Operation - vagotomy.

Vagotomy was performed on this patient after 8 days on a diet of 90 g. protein and 2,500 calories. For the first two days after operation he received no protein food, and afterwards his diet was very slowly built up so that on the 11th day an intake of only 28 g. protein and 524 calories was recorded, and this involved a negative nitrogen balance of 3.87 g. nitrogen. His urine nitrogen excretion was raised above starvation level of 10 g. per day (Benedict 1915) for the first 4 days after operation, but after--wards remained between 10 and 12 g. nitrogen a day so that he lost a total of 117 g. nitrogen in 11 days. This nitrogen loss was therefore due almost entirely to lack of food and only a small part could have resulted from the trauma ofoperation.

NITROGEN BALANCE STUDIES IN FOUR SURGICAL CASES.

(Other than Partial Gastrectomy)

In addition to the cases of patients with partial gastrectomy, the following miscellaneous surgical cases have been included as further illustrations of the effect of a surgical trauma on the nitrogen equilibrium of patients.

Case No. 22 (J.S.) Aged 62; occupation, fruit merchant.
Operation - subtrochanteric osteotomy of R. hip with immediate immobilisation of R. lower limb in plaster.

The patient was given a diet of 83 g. protein and 1,940 calories for a week prior to his operation, after which his food intake was gradually increased, so that by the 6th post-operative day he was once again in nitrogen equilibrium on an intake of 68 g. protein and 1,530 calories. No marked rise in urine nitrogen excretion after operation was, however, observed.

Case No. 23 (A.M.) Aged 17; occupation, brewery labourer.
Operation - bilateral spinal fusion with grafts from tibiae.

Metabolic studies were made on this patient for 10 days prior to operation when his daily food intake varied from 24 to 89 g. protein and 680 to 2,119 calories. After operation no immediate rise in urine nitrogen excretion was observed and except for the first two days, when his food intake was diminished, he appeared to be in nitrogen equilibrium. There was no evidence of a nitrogen catabolic phase having occurred.

Browne et al. (1945)have shown that debilitated

patients /

patients do not respond in a normal manner to trauma. It seems probable that this patient, who was in a poor nutritional state, had no nitrogen reserves available for a catabolic reaction. This may also be the reason for the small nitrogen loss of Case No. 16.

Case No. 24 (D.H.) Aged 36; occupation, motor engineer.
Diagnosis - hypertension.
Operation - bilateral splanchnecectomy.

This patient received a diet of 90 g. protein and 2,500 calories for 8 days. The first part of the proposed operation of bilateral splanchnecectomy was then performed. A slight rise in urine nitrogen excretion was observed on the next day, after which it remained at a fairly constant level, so that despite an intake of 90 g. protein and 2,000 calories having been attained by the 8th day, he was in negative nitrogen balance for 10 days. There was, therefore, evidence that the patient had responded to trauma caused by the operation in a normal manner and it was wondered whether the second part of the operation would elicit a second catabolic phase. Unfortunately, however, the patient died on the theatre table.

Case No. 25 (W. McI.) Aged 45; occupation, railway worker.
Diagnosis - sciatic causalgia.
Operation - R. Lumbar sympathectomy.

This patient maintained a slight positive nitrogen balance of 2.72 g. nitrogen per day for 9 days on an intake of 91 g. protein and 2,542 calories for 9 days prior to his operation. No increased urine nitrogen excretion was observed after the operation, and the small negative nitrogen balances recorded for the 4 days after operation, when the daily protein intakes were 3, 6, 11 and 35 g. protein respectively, were never greater than 9 g. nitrogen a day, so that his net nitrogen losses for the 6 days after /

after operation were only 22.54 g. nitrogen. He did, however, lose 6 lb. in weight. Unlike the other cases previously described he was able to maintain nitrogen equilibrium on an intake of 52 g. protein and 1,662 calories 4 days after his operation. This may be due to the fact that sympathectomy is a less severe operation than that of partial gastrectomy, as there was no reason to suppose that the patient was in a debilitated state.

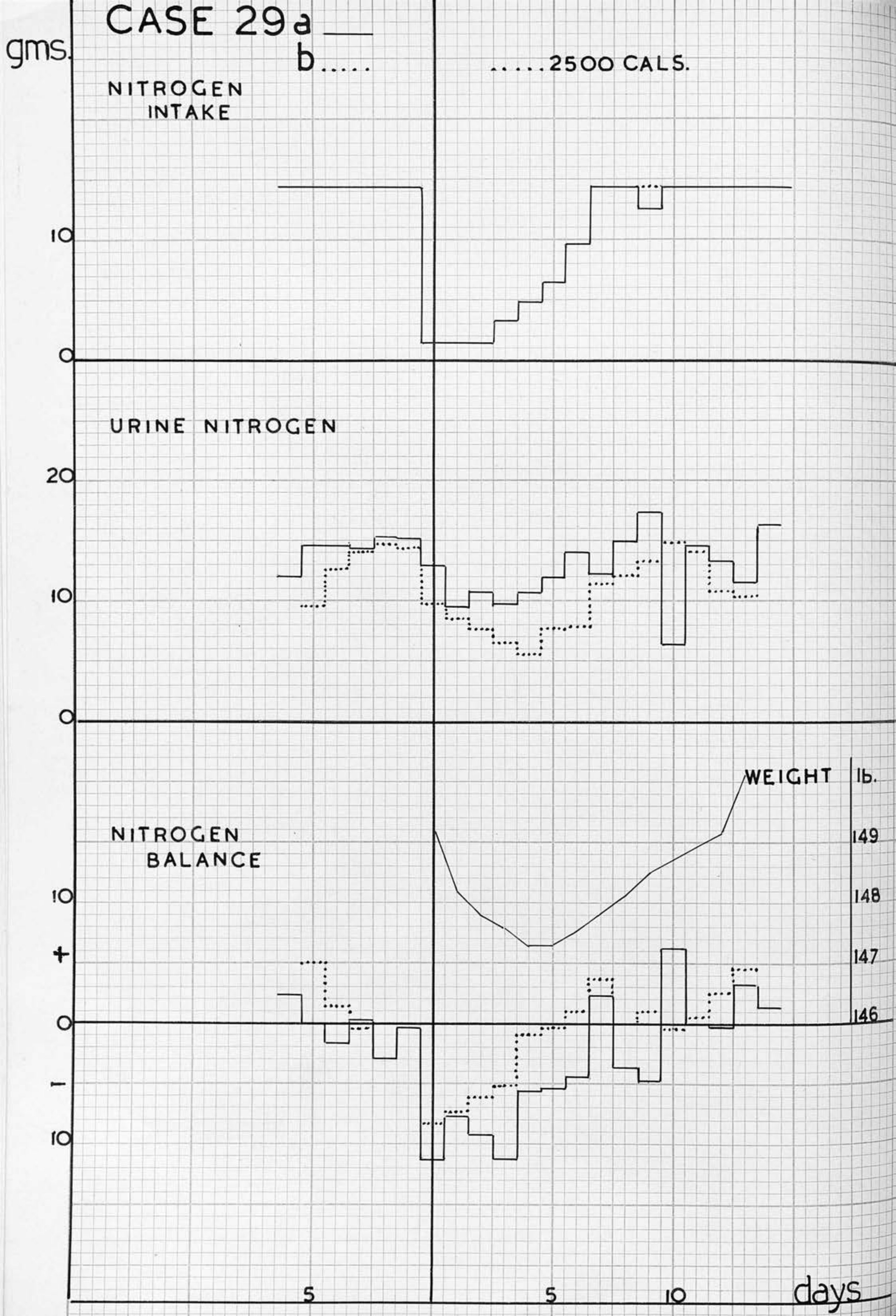
NITROGEN BALANCE STUDIES ON VOLUNTEER SUBJECTS GIVEN POST GASTRECTOMY DIETS.

In an endeavour to determine to what extent the post-operative period of negative nitrogen balance is due to semi-starvation, it was decided that some useful information might be obtained by giving a post-gastrectomy diet to normal individuals, and observing what effect it had on their nitrogen balance.

A preliminary investigation was carried out on the following patient.

Case No. 26 (R.S.) Aged 20; occupation, soldier.
Diagnosis - lateral popliteal nerve lesion.

This patient was in hospital with his leg immobilised in plaster on account of a nerve lesion sustained 8 months previously. Preliminary studies showed that he was in nitrogen equilibrium and therefore a suitable subject for these investigations. After taking a diet of 96 g. protein and 2,569 calories for 4 days, he was given in addition 160 g. Pronutrin a day and 2 days later the protein intake was increased to 118 g. protein and his total caloric intake to 3,426 calories. On such a diet he maintained an average positive balance of 6.5 g. nitrogen per day. For 1 day his diet was prepared to contain the equivalent in nitrogen fat and carbohydrate of 2 pints of blood in order to imitate the feeding conditions of a gastrectomy patient on the day of operation. At that time it was not appreciated that the metabolism of blood given intravenously is unlikely to be the same as that of food given by mouth, and also that in most instances the blood only replaces that lost at operation. He was then given a diet resembling as far as possible in protein and caloric content that given to post-operative gastrectomy patients, allowance /



CASE 29 a ___
b .....
..... 2500 CALS.
gms.
NITROGEN INTAKE
10
0
URINE NITROGEN
20
10
0
WEIGHT
lb.
149
148
147
146
NITROGEN BALANCE
10
+
0
-
10
5
5
10
days

allowance being made for the usual intravenous infusions of glucose. At the request of the patient his intake after 3 days of semi-starvation was increased a little more rapidly than had been originally intended. Six days after the so-called "operation" day he was receiving 80 g. protein and 1,973 calories from his food, and was again in positive nitrogen balance. In these 6 days he had a total negative nitrogen balance of 43.83 g. nitrogen. His urine nitrogen dropped rapidly from an average of 29.57 g. nitrogen to 17.7 g. nitrogen on the day after "operation" and thereafter remained fairly constant at about 11 g. nitrogen per day despite changes in the actual protein and caloric intake.

This investigation was then repeated with three volunteer medical students, all aged 20 years old.

Case Nos. 27 (R.R.), 28A (D.P.), 29A (L.M.).

These students were admitted to a small ward for three weeks. For the first week they received a high protein diet of 91 g. protein and 2,502 calories and continued with light duties as ward clerks. During this control period two of the students (D.P. and L.M.) were in slight negative nitrogen balance, due probably to their normal caloric intake of some 3,000 - 3,500 calories being lowered on admission to hospital. The students were then confined to bed for 5 days and their intake cut to one of 10 g. protein and 580 calories in imitation of a post-operative partial gastrectomy diet. The first day on this diet was considered to be the day of "operation" but no allowances were made for any blood transfused or blood lost for reasons previously stated. The diet was gradually increased so that 6 days after the "operation" day they were back on their original diet of 91 g. protein and 2,502 calories and again all in positive nitrogen balance. Their net nitrogen losses during this period had been 46.81 g. (D.P.), 44.08 g. (L.M.) and 37.97 g. (R.R.) nitrogen.

A summary of the results obtained from these 4 cases is given in Table 6.

Despite /

TABLE 6.

Results of Administration of Post-Gastrectomy diets to Volunteers.

Case No.	Intake Cals.	Post-op. N. Balance g/day	Duration Neg. Balance days.	Net Neg. N Balance g.	Pr. Intake for +ve. Balance g.	Weight changes lb.
26	Variable	+6.50	6	43.82	80	-4.25
27	Variable	+0.88	6	37.97	91	-2.0
28A	Variable	-1.44	6	46.81	91	-3.5
29A	Variable	-0.39	6	44.08	91	nil
28B	2,500	-3.29	5	20.75	60	-2.0
29B	2,500	+0.97	5	19.89	60	-3.0
30	2,500	-1.92	5	24.25	60	-1.3

Despite considerable differences in the physical make-up of the four volunteers, very similar results were obtained in all 4 cases. The net negative nitrogen balances for the 6 days following the so-called "operation" averaged 43.17 g. nitrogen and only ranged from 37.97 to 46.81 g. nitrogen, whereas, in the results obtained from the partial gastrectomy patients, considerable variation was encountered. The period of negative nitrogen balance lasted in all cases for 6 days, and a positive nitrogen balance was not obtained with an intake of 60 g. protein and 1,505 calories, but was obtained on raising the intake to 91 g. protein and 2,502 calories with the students and 80 g. protein and 1,973 calories with Case No. 26. The results did not appear to be affected by the previous protein and caloric intake.

Benedict (1915) in his study of a starving man has shown that for the first 15 days of starvation the urine nitrogen excretion after the first day remains fairly constant at about 10 g. nitrogen per day. It was interesting, therefore, to find that in these studies during the semi-starvation period the urine nitrogen levels did not usually fall below 10 g. nitrogen a day.

These investigations have confirmed previous impressions /

impressions gained that, with the dietary regime usually prescribed, post-gastrectomy patients will of necessity undergo a period of negative nitrogen balance for at least 6 days after operation. These patients will then only be able to maintain nitrogen equilibrium if their intake is over 65 g. protein per day. For patients on whom the operation of partial gastrectomy has been performed, a net negative nitrogen balance of over 50 g. nitrogen, and a urine nitrogen excretion of over 12 g. nitrogen per day during the period of low protein and caloric intake, are probably indicative of the patients' ability to respond to surgical trauma in a normal manner with a catabolic phase.

<u>The Effect of Raising the Carbohydrate Content of a Post-Gastrectomy diet on Nitrogen Metabolism.</u>

The protein sparing properties of carbohydrates have already been discussed in the first section of this thesis and are well-known. With this information in mind, the studies described above were repeated three months later with the same changes in protein intake, but with the caloric intake maintained at a constant level of 2,500 calories by the drinking of large quantities of fruit drinks during the period of /

of semi-starvation. Lactose was chosen as the carbo--hydrate as it is relatively cheap (one shilling and sixpence per lb.) and not so nauseating as glucose or sucrose when taken in large quantities. The nitrogen intake was gradually increased after the so-called "operation" as in the previous experiment. In connection with other work to be discussed later the salt intake was kept at a constant level. Two of the three volunteers had taken part in the previous investigation.

Case Nos. 28B (D.P.), 29B (L.M.), 30 (A.McK.).

From the summary of the results in Table 6 it will be seen that the maintenance of a caloric intake of 2,500 calories resulted in the period of negative nitrogen balance being shortened from 6 to 5 days and a positive nitrogen balance being obtained with an intake of 60 g. protein per day compared with 90 g. protein in the previous experiment. A reduction in the average net nitrogen loss from 44 .17 g. nitrogen to 22.45 g. nitrogen was observed. In the first series the urine nitrogen excretion did not fall below 10 g. nitrogen per day, while in the second series it fell to about 5 g. nitrogen per day during the period of low nitrogen intake. Despite the high carbohydrate intake /

intake no glucose was detected in any of the urine specimens passed.

These experiments have provided further evidence of the value of a high caloric diet to persons on low protein intakes. In practice, however, it is difficult to give patients such large quantities of carbohydrate as those tolerated by the medical students. The enormous volume of fluid needed to give the carbohydrate intravenously makes this method of administration impossible. The other alternative would be to give the Lactose (or glucose) by intubation direct into the jejunum, but if this method of feeding was to be adopted it would obviously be advisable to give some form of protein food at the same time and not just carbohydrate.

THE USE OF PRONUTRIN IN SURGICAL CASES.

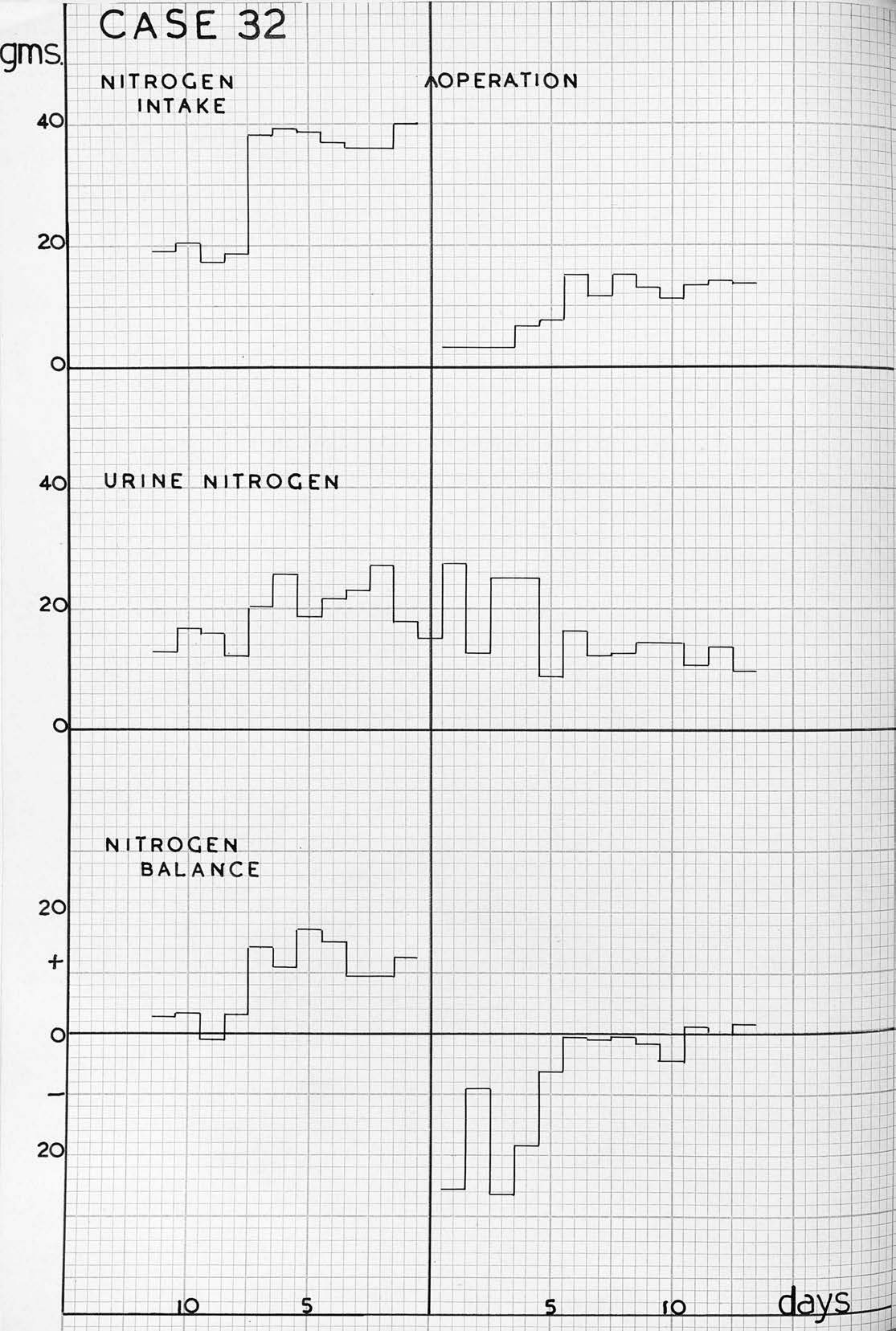
Oral protein hydrolysate preparations have theoretically two possible uses for the surgical patient: firstly, as the means of increasing the pre-operative protein intake so that the patient is in a good nutritional state to withstand the operation; secondly, as an easily digested food which can be given to the patient in the immediate post-operative period, and can be continued until normal food can be taken in adequate amounts. The effect of semi-starvation on the nitrogen balance of gastrectomy patients has already been discussed and it was decided to see if the post-operative negative balance could be abolished, at least in part, by adequate feeding.

Co Tui et al. (1944) claimed that by the administration of Amigen (containing 24-37 g. nitrogen) and dextrose (sufficient to give 50 calories per kg. body weight) they had maintained positive nitrogen balances in their patients after gastrectomy. These patients recovered more quickly than did those of a control series given the normal ward diet, and they gained weight. It was not however /

however possible to correlate the gains in weight with the amount of nitrogen retention. In contrast, Howard (1944, 2) in his study of the influence of diet on post-traumatic nitrogen deficiencies,reported that two similarly built patients, on whom identical operations were performed, showed identical net nitrogen losses, though one of the patients was fed by intubation with Amigen and the other was fed merely according to appetite. The excess nitrogen administered was excreted in the urine.

Of the following 5 cases, 1 was given Pronutrin 9 days after operation when he was in nitrogen equilibrium, to see if it would enable him to put on weight more rapidly. The other 4 were given Pronutrin supplementation to a high protein pre-operative diet, and of these 2 received Pronutrin in the post-operative period. A nasal tube was passed into the duodenum at operation and administrat-ion of a solution of 100 g. Pronutrin and 198 g. glucose in 800 ml. water was commenced a few hours afterwards. It was intended to begin normal feeding as soon as possible so that the giving of the Pronutrin and glucose could gradually be curtailed and a constant nitrogen and caloric intake could be maintained.

Case No. 31. /



CASE 32
gms.
NITROGEN INTAKE
OPERATION
40
20
0
URINE NITROGEN
40
20
0
NITROGEN BALANCE
20
+
0
–
20
10
5
5
10
days

Case No. 31 (W.McE.) Aged 45; occupation, Commercial traveller.
Diagnosis - Chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient, who had an active tuberculous lesion of the right apex of the lung, was admitted to hospital for a fortnight prior to his operation, and was given a diet of 119 g. protein and 2,848 calories on which he maintained an average positive nitrogen balance of 3.28 g. per day and gained 2 lb. in weight. After operation he was given the routine post-gastrectomy diet and for 6 days was in negative nitrogen balance with a net total loss of 71.25 g. nitrogen. He reached nitrogen equilibrium on an intake of 93 g. protein and 1,849 calories. His normal diet was then supplemented with 160 g. Pronutrin per day, and an average positive nitrogen balance of 8.7 g. per day resulted, although no increase in weight was recorded. The patient was unable to tolerate the Pronutrin for a longer period than 5 days, so it was discontinued. He was in nitrogen equilibrium during the next 7 days but lost another pound in weight, making a total loss of 9 lb. in the post-operative period.

Case No. 32 (A.S.) Aged 40; occupation, canteen worker.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient received for 7 days before his operation 160 g. Pronutrin in addition to a diet containing 129 g. protein, and his caloric intake was 3,328 calories. Despite daily stomach aspirations he retained an average of 12.65 g. nitrogen per day. His negative nitrogen balance during the 6 days after operation amounted to a total of 86.76 g. nitrogen. He was in nitrogen equilibrium on the 6th day on an intake of 97 g. protein and 1,573 calories.

Case No. 33 (T.M.) Aged 40; Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient maintained an average positive nitrogen balance of 12.69 g. per day on a daily intake of 126 g. protein, 160 g. Pronutrin and a total of 3,330 calories. After operation he was in negative nitrogen /

nitrogen balance for 6 days, and a net loss of 45.51 g. nitrogen was recorded, which is considerably lower than the average figure of 70.7 g. nitrogen found in the control series of patients. The high positive nitrogen balances obtained before operation make it improbable that the catabolic response was limited by available nitrogen stores as he was not poorly nourished, so that some other explanation is needed. After operation he required an intake of 99 g. protein and 2,445 calories to attain nitrogen equilibrium. Attempts were made to supplement this diet with Pronutrin, but after 2 days the patient refused to take it.

Case No. 34 (W.F.) Aged 41; occupation - undertaker.
Diagnosis - stomal ulcer.
Operation - partial gastrectomy.

A diet of 137 g. protein, 160 g. Pronutrin and a total of 3,382 calories was taken by this patient for 7 days before operation. An average nitrogen retention of 11.59 g. per day was recorded during this period.

On the day of operation and on the day following the patient was given Pronutrin and glucose solution (equivalent to 47 g. protein and 740 calories) by intubation. Analysis of the gastric aspirations showed that approximately 90% of the glucose and Pronutrin fed was absorbed. This method of feeding had, however, to be discontinued on account of con--siderable discomfort being caused to the patient by increased gastric secretion resulting from the administration of the Pronutrin. The period of negative nitrogen balance lasted for 7 days, and nitrogen equilibrium was not attained until the patient's diet had been increased to contain 94 g. protein and 1,887 calories. A net negative nitrogen balance of 80.91 g. nitrogen for the 6 days following the operation was recorded. The patient lost a total of 10 lb. in weight.

Case No. 35 (W.H.) Aged 43; occupation, surface worker in mines.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient was also given a pre-operative diet of 137 g. protein, supplemented with 160 g. per day Pronutrin /

TABLE 7.

Effect of Pronutrin Supplementation to Pre-Operative Diet on Nitrogen Balance.

Case No.	Pre-Op. N. Intake g/day	Post-Op. N Balance g/day	Net Neg. N Balance for 6 days g.	Length of Neg. Balance g.	Protein Intake for Equilibrium N. g.	Loss of Wt. lb.
31	18.04	+3.28	71.25	6	93	9
32	39.84	+12.65	86.76	6	97	14.3
33	39.36	+12.69	41.51	6	99	4.2
34	41.12	+11.59	80.91	7	94	10
35	41.12	+13.32				9
Control	Average		70.70	6.85	71	8.1
	Range		38.99-97.96	6-10	66-80	3-10.5

Pronutrin for a week. This resulted in an average retention of 13.32 g. nitrogen per day. Feeding with Pronutrin and glucose solution by intubation was begun on the day of operation and continued the next day, so that daily intakes equivalent to 75 g. protein and 1,252 calories were achieved. As in the previous case, the administration of Pronutrin caused increased production of gastric secretions, far in excess of that normally encountered, so that it had to be stopped. On the day after operation approximately 55% of the glucose and Pronutrin administered was absorbed, the remainder being present in the 3,000 ml. suction fluid withdrawn; this relatively low absorption may have been due to too frequent gastric aspirations. Gastric aspirat--ions on the 2nd day after operation produced 4,250ml. of fluid containing 9.93 g. chloride (as NaCl), while on the 3rd day 8,400 ml. of fluid containing 13.44 g. chloride (as NaCl) were obtained, and this despite no more Pronutrin being given.

Convalescence was complicated by severe hiccoughs, which had to be relieved by a bilateral phrenic nerve crush, 3 days after partial gastrectomy. Infusions were given of blood and plasma and normal feeding was not recommenced until 4 days later. A second catabolic phase occurred and with an intake of 80 g. protein and 1,706 calories, nitrogen equilibrium is not re-established in the patient for a further 6 days. A total loss in weight of 9 lb. occurred during his stay in hospital. The complic--ation of the hiccoughs makes it impossible for this case to be compared with others as regards the length and extent of the period of negative nitrogen balance.

All the patients given Pronutrin supplements to their pre-operative high protein diets were able to retain approximately 62% of this extra nitrogen. Their nitrogen losses after operation were, with the exception of Case No. 35, within the normal range encountered in the control series (Table 7), so that there was no evidence that the extra nitrogen was lost /

lost from the body as the result of protein catabolism. Post-operative weight losses appeared to be unaltered by this treatment, so that the regime had no obvious beneficial effect. None of the patients in this series was in a poor nutritional condition.

As a means of increasing the patient's post--operative food intake Pronutrin administration by intubation was not successful, since it acted as a stimulant to gastric secretion at a time when it is desirable to keep these secretions at a minimum. The presence of "free acid" was not, however, detect--ed in the aspirated fluid.

PARENTERAL PROTEIN ADMINISTRATION IN SURGICAL CASES.

The classic work of Elman (1940) has shown that the protein requirements of man can normally be met by parenteral feeding with an enzymic hydrolysate of casein. Animal experiments have shown that this method of feeding is capable of causing the regenerat-ion of plasma proteins (Madden et al. 1941, Brunschwig 1942 and Elman et al. 1943, 1 and 2) and of synthesis-ing tissue proteins (Ross and Elman 1948). Chemical analysis has proved that an enzymic hydrolysate of casein will provide adequate amounts of all the essential amino acids.

The possibility of employing this method of feeding for surgical patients, who are unable to take adequate amounts of food by mouth, has been examined by several workers. Elman gave Amigen intravenously to surgical patients and found that although positive nitrogen balances were not always attained, the patients appeared to benefit from this treatment. Mulholland (1943) and Co Tui et al. (1944) administer-ed Amigen and glucose to patients immediately after operation by both intubation and intravenous infusion, so that intakes of approximately 0.6 g. nitrogen and 50 calories per kg. of body weight per day were achieved. /

achieved. In this way they were able to obtain positive nitrogen balances directly after operation. Riegal (1945) found that after cranial and gastric operations daily intakes of at least 21 g. nitrogen and 2,100 calories were needed for nitrogen equilibrium in the immediate post-operative period. Werner (1947), in a study of the protein requirements of surgical patients, gave a mixture of pure amino acids parenterally and found that intakes of 0.3 to 0.5 g. nitrogen per kg. body weight prevented part of the protein catabolism that normally occurs after operat--ion, and that in many instances as much as 20 to 28 g. nitrogen together with 3,000 ml. 5% glucose were necessary in order to maintain nitrogen equilibrium.

Howard (1944,2) and Peters (1944) were unable to prevent negative nitrogen balances after operation by the giving of infusions of Amigen in amounts consider--ably less than those quoted above, but containing more nitrogen than is normally needed for the healthy person. It is thus apparent that the patients' requirements of nitrogen are considerably increased by operation, so that two to three times the normal amounts must be given if nitrogen equilibrium is to be obtained; this necessitates the administration of a minimum of 4,000 ml. Amigen per day and in addition carbohydrate /

carbohydrate is needed to maintain an adequate caloric intake. Whether the administration of these large quantities of infusion fluids is to be desired is questionable.

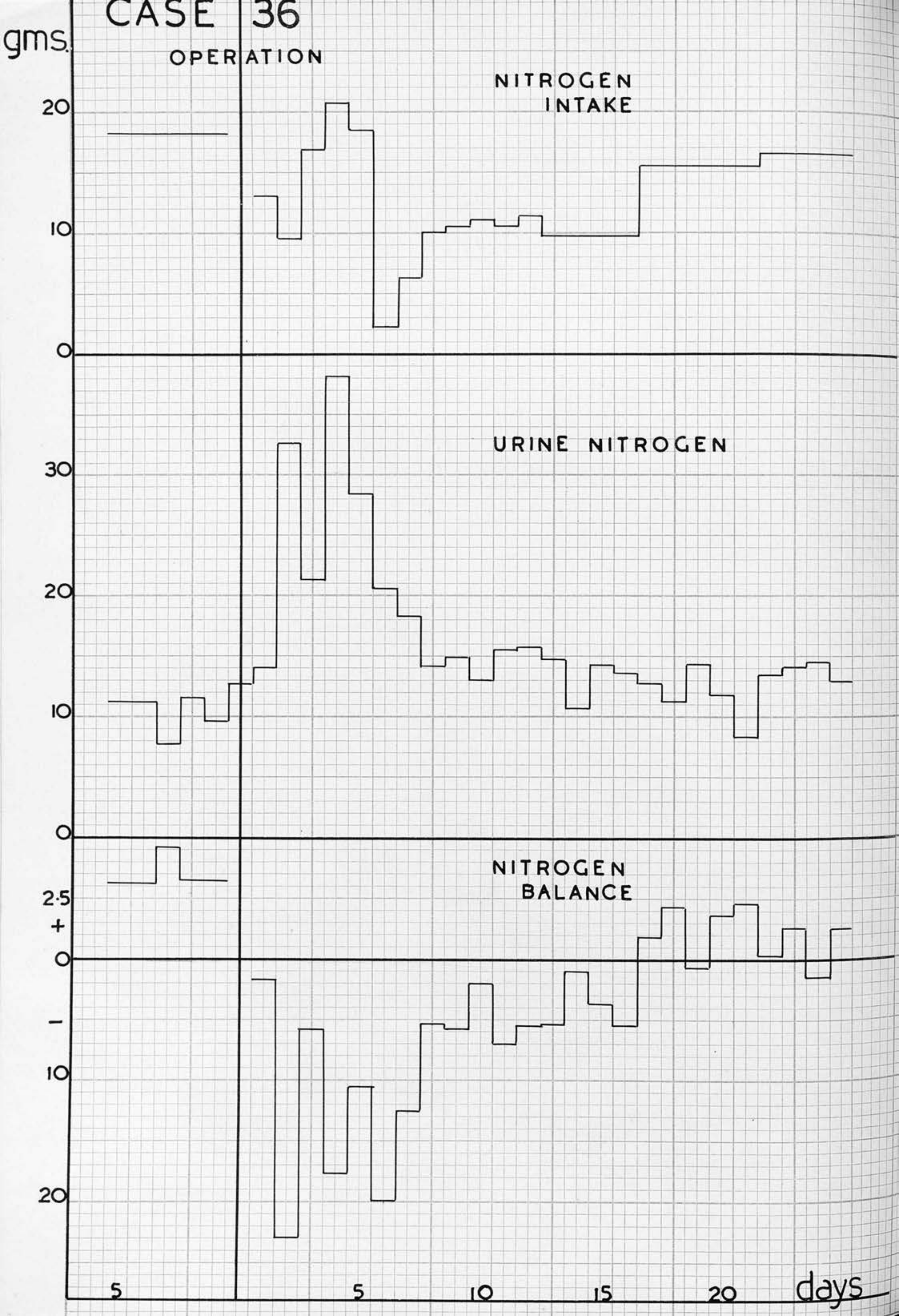
Co Tui states that the convalescence was shortened in his patients by post-operative high protein feeding, and that the usual losses of weight did not occur. Mayock (1946) by means of ballistocardiograms, and pulse rate and blood pressure determinations, has shown that extra feeding after operation improves the circulation. Cole et al. (1947) demonstrated that in cases of herniorraphy and cholecystectomy high protein feeding prevented impaired liver function following operation. On the other hand, Bigham et al. (1947), in reviewing the indications for intravenous alimentation, consider that 18 g. nitrogen and 2,400 calories are the maximum amounts that can safely be given intravenously and that large volumes and very hypertonic solutions should be avoided. Elman (1949) recommends that, as a routine measure after operation, 2,000 ml. Amigen, containing 100 g. of both Amigen and carbohydrate, should be given. This will meet the minimum daily nutritional requirements in the average patient, apart from vitamins, although nitrogen balance will not necessarily be maintained.

<u>Casydrol</u>. /

Casydrol.

Administration of the large quantities of protein hydrolysate solution advocated by Co Tui and others was not considered desirable and so in the following cases to be described, it was aimed at giving the patients a minimum of 2,700 ml. Casydrol, i.e. 17.61 g. nitrogen and 984 calories, for each of 4 to 5 days after operation and at the same time in--creasing their ordinary diet, so that their total intake was maintained at as high a level as possible and variations were minimal. The Casydrol infusions were given at the rate of 500 ml. in 2 to 3 hours, and in addition the patients received infusions of 0.9% saline. It was not expected that the infusions would prevent the occurrence of a negative nitrogen balance, but it was anticipated that the nitrogen losses would be less than those usually encountered after the operation of partial gastrectomy.

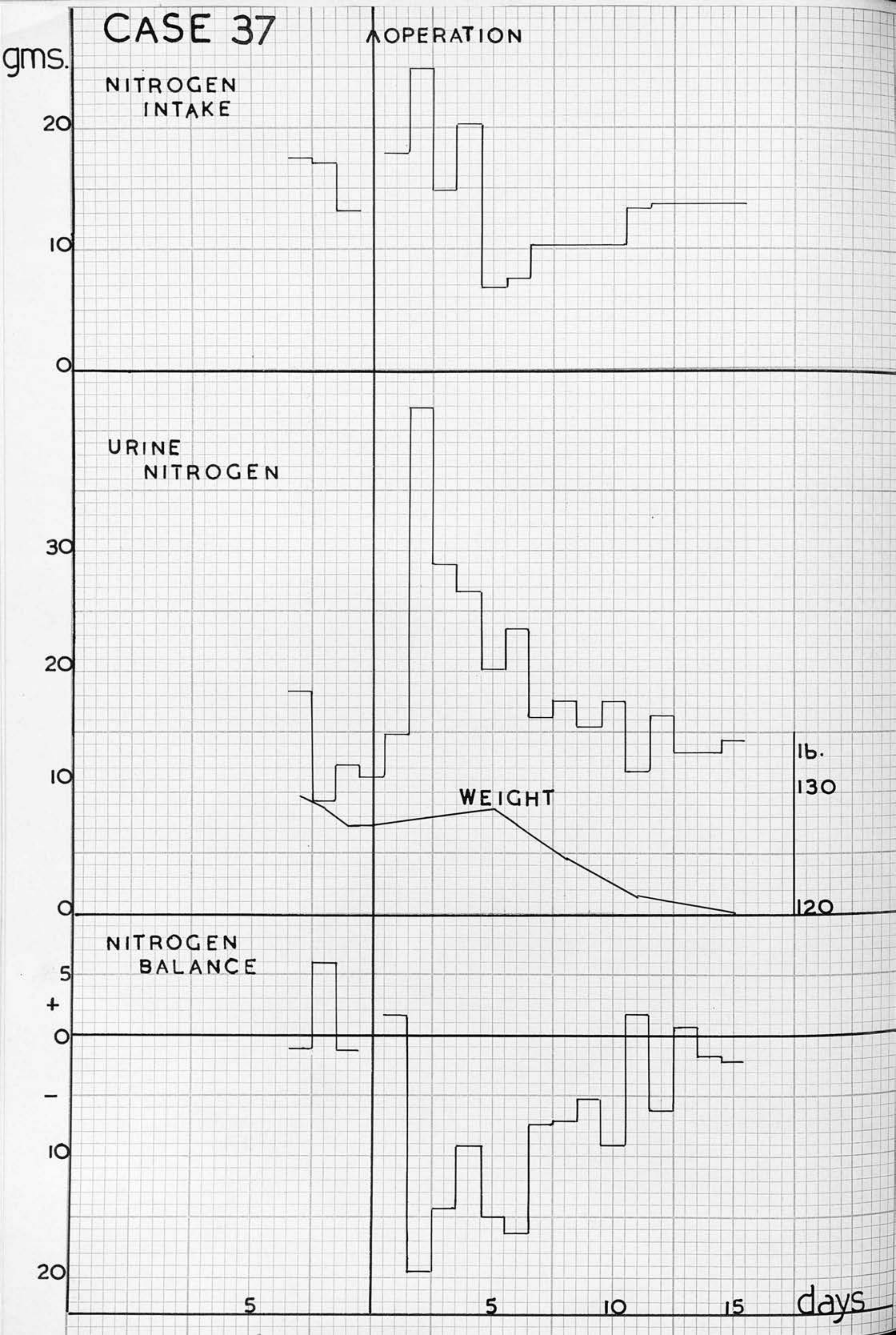
Analysis of the urine of 4 gastrectomy patients (Cases Nos. 17, 42, 44, and 45), one splanchnecectomy patient (Case No. 24) and of 3 of the volunteers taking post-gastrectomy diets (Cases Nos. 27, 28A and 29A) has shown that the total daily amino acid nitrogen excretion is a fairly constant value for a particular individual. It does not appear to be affected either by alterations in the diet /


CASE 36
gms.
OPERATION
NITROGEN
INTAKE
20
10
0
URINE NITROGEN
30
20
10
0
NITROGEN
BALANCE
2·5
+
0
−
10
20
5
5
10
15
20
days

diet or by operation, though in one instance (Case No. 17) the daily excretion was considerably raised when the patient developed phlebitis. In the calculation of the proportion of Casydrol infused which had been metabolised by the patient, an average figure for the pre-operative amino acid and peptide nitrogen excretion was obtained, and it was assumed that similar amounts would be excreted after operation. Any excesses over these amounts were considered to have resulted from unmetabolised Casydrol which had been "spilt" into the urine. For the purpose of these calculations it was also assumed that all the unmetabolised Casydrol had been excreted 24 hours after the infusion had stopped. The results given may, therefore, tend to be on the high side.

Case No. 36 (F.N.) Aged 38; occupation, joiner.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

After 6 days in hospital on a diet of 144 g. protein and 2,758 calories, which resulted in a retention of an average of 6.11 g. nitrogen per day, operation was performed on this patient. For 5 days afterwards he was given infusions of Casydrol. The amounts given varied from day to day (Appendix) as the infusions had to be stopped several times, and the veins changed on account of thrombosis. An average of 2,046 ml. per day was achieved for 5 days and in addition oral feeding was begun. The Casydrol infusions supplied a daily average of 13.42 g. nitrogen (6.75 g. amino acid nitrogen and 3.27 g. peptide nitrogen) and 816 calories. Urine analysis showed that approximately 60% of the amino acid nitrogen and less than 50% of the peptide nitrogen infused /



CASE 37
OPERATION
gms.
NITROGEN INTAKE
20
10
0
URINE NITROGEN
30
20
10
0
WEIGHT
lb.
130
120
NITROGEN BALANCE
5
+
0
-
10
20
5
5
10
15
days

infused was metabolised. No urine amino acid and peptide nitrogen determinations had been carried out prior to operation, so that average figures had to be assumed for the calculation. No reactions from the infusions were observed, though the patient remained febrile for 12 days.

The negative nitrogen balance for the first 6 days after operation totalled 78.96 g. nitrogen. Convalescence was retarded by phlebitis and a leg abscess had to be drained on the 12th day. This no doubt was partly responsible for nitrogen equilibrium not being attained on an intake of 68 g. protein and 1,995 calories so that it was not until 17 days after partial gastrectomy had been performed that a positive nitrogen balance was recorded. He lost 9 lb. in weight as the result of the operation.

Case No. 37. (T.R.) Aged 26; occupation, sewing-machine mechanic.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient was given Casydrol infusions for 4 days after operation (Appendix) . He received an average of 2,805 ml. Casydrol on each of these days, which gave him a daily intake of 18.4 g. nitrogen (9.37 g. amino acid nitrogen and 4.49 g. peptide nitrogen) and 1,024 calories in addition to small amounts of food taken by mouth. Of the nitrogen given parenterally, approximately 74% of the amino nitrogen and 24% of the peptide nitrogen was metabolised. A net negative nitrogen balance of 72.39 g. nitrogen was observed for the 6 days after operation, and it was not until 11 days after operation that a positive nitrogen balance was first recorded, when the patient's intake had risen from 65 g. protein and 1,654 calories on the 7th day to 84 g. protein and 2,020 calories.

One rigor occurred during the infusions, but the patient did not complain of nausea and there was no resulting anorexia when the infusions were stopped. A loss in weight of 7 lb. was observed.

Case No. 38 /

Case No. 38 (J.B.) Aged 35; occupation, pig manager.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient retained an average of 3.96 g. nitrogen per day for 5 days before his operation. On the day after operation Casydrol infusions were begun, but unfortunately phlebitis developed and severe rigors occurred on the 3rd and 4th days so that the infusions were stopped after only 7,020 ml. Casydrol had been given, containing a total of 46 g. nitrogen (23.16 g. amino acid nitrogen and 11.23 g. peptide nitrogen) (Appendix). 67% of the amino acid nitrogen and 26% of the peptide nitrogen infused was metabolised. Cessation of the infusions resulted in the patient immediately becoming afebrile.

During the six days after operation this patient had a net negative nitrogen balance of 80.58 g. nitrogen. Oral feeding was started 2 days after operation so that on the 6th day he was taking a diet of 70 g. protein and 1,595 calories. He was not, however, in nitrogen equilibrium until the 10th day when his diet had been increased to one of 81 g. protein and 2,080 calories. He lost 12 lb. in weight as the result of the operation.

Case No. 39 (J.F.) Aged 42; occupation, -
Diagnosis - Chronic duodenal ulcer.
Operation - partial gastrectomy.

On the daily intake of 114 g. protein and 2,034 calories, the patient retained an average of 3.84 g. nitrogen per day. After operation, Casydrol infusions averaging 2,545 ml. per day provided the patient with 14.38 g. nitrogen (8.4 g. amino acid nitrogen and 3.97 g. peptide nitrogen) and 868 calories for each of the 4 days. On the 5th day the patient only received 540 ml. Casydrol and the infusions were then stopped. Of the Casydrol administered it was calculated that approximately 60% of the amino acid nitrogen had been metabolised.

On the 5th and 6th days the patient's nitrogen and caloric intake dropped considerably, but by the 9th day he was taking a diet of 114 g. protein and 2,556 calories, and was almost in nitrogen equilibrium. He /

TABLE 8.

Effect of Casydrol Infusion on Nitrogen Balance.

Case No.	Vol.of Casydrol ml.	Net Neg.N Balance for 6 days post-op. g.	Net N. Intake for 6 days post-op. g.	Duration of Neg. Balance g.	Protein Intake for +ve Balance	Loss in wt. lb.	Max. urine N g./day	% Amino Acid N. Metab.	% Peptide N.Metab.
36	10,260	78.96	80.94	10	97	9	38.64	60	50
37	11,190	72.39	91.70	10	84	7	41.80	74	24
38	7,020	78.33	65.57	9	81	12	26.78	67	-
39	10,720	82.63	84.69	9	114	4½	35.65	60	26
40	Amigen 6,420	51.06	73.09	6	90	6	30.54	90	47
Controls	Average	70.7	25.83	6.85	71	8.1	17.82		
	Range	38.99-97.96	17.12-32.94	5-10	65-80	3.00-10.50	12.36-30.46		

He only lost $4\frac{1}{2}$ lb. in weight.
(Table 8).

The results obtained from the nitrogen balance studies made on 4 patients receiving Casydrol infusions after partial gastrectomy are summarised in Table 8. They do not suggest that the patients have benefitted from these infusions. An average of 65% of the amino acid nitrogen and 25% of the peptide nitrogen appears to have been metabolised. The fate of that part of the infused nitrogen, which is neither amino acid nor peptide nitrogen, is unknown, so that these figures indicate that a minimum of 39% of the total nitrogen given has been metabolised. A considerable amount of the nitrogen given has thus been wasted. Confirmation of this fact can be found by examining the daily total urine nitrogen figures of these patients which are considerably higher than those found in the control studies during the catabolic phase.

In spite of apparent increased nitrogen intakes during the first 6 days after operation, the net negative nitrogen balances for this period were slightly higher than those found in patients receiv-ing normal ward feeding, so that even the nitrogen from the Casydrol, which had been metabolised, does not /

not appear to have been utilised.

The Casydrol infusions tended to cause anorexia so that oral feeding was sometimes started later than in the control patients and consequently adequate nitrogen and caloric intakes for nitrogen equilibrium were only slowly attained. It was observed that higher levels of protein intake were needed for nitrogen equilibrium than would be normally expected.

All the patients receiving Casydrol were febrile during the period of the infusions and in some instances rigors were recorded. A rise in body temperature is, however, a common occurrence after operation and per se is not considered to be responsible for protein catabolism. (Graham and Poulton 1912). The low utilisation of the Casydrol cannot, therefore, be explained by mere rises in the body temperature of the patients.

The occurrence of phlebitis, considered by the clinicians to be due probably to the glucose present in the Casydrol solution, may well have been partly responsible for prolonging the catabolic phase; but a more probable factor to be considered is that of the inadequate caloric supply of the infusions which would have resulted in at least part of the protein hydrolysate /

hydrolysate being used for energy purposes. Elman (1944,1945) has shown that in a restricted diet priority should be given to protein over caloric needs, since small amounts of glucose permit adequate utilisation of protein and for short periods the rest of the caloric needs can be supplied by the tissue fat. For this reason, since supplementary feeding by intubation had to be avoided, no glucose infusions were given and the caloric intakes were limited by the amounts of Amigen that could be infused.

There is also the possibility that the low utilisation of the Casydrol may be due to some defect in its preparation which does not appear in the American protein hydrolysate preparations. It was to test this supposition that the nitrogen balance studies were repeated in the following case, and Amigen infusions were given in lieu of Casydrol.

Amigen.

Amigen is an enzymic digest of casein manufactured by Mead and Johnson & Co., Indiana, and supplied as a fine powder. For these studies the Amigen was dissolved in 5% glucose to give a 5% solution and then immediately autoclaved in order to maintain sterility. This solution had a pH of 5.26 and the following composition:-

g./100ml. /

	g./100ml.
Total Nitrogen	0.652
Amino Acid Nitrogen	0.420
Peptide Nitrogen	0.140
Chloride	0.850
Sodium	0.855

It therefore contained relatively more of the nitrogen in amino acid form than did the Casydrol, a 100ml. of which contained 0.656 g. total nitrogen, 0.33 g. amino acid nitrogen and 0.16 g. peptide nitrogen.

Case No. 40. (R.K.) Aged 39; occupation, miner.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient was in nitrogen equilibrium prior to his operation. On the day after operation Amigen infusions were begun (Appendix) and for 4 days the patient received an average of 1,605 ml. Amigen per day, which supplied him with 10.46 g. nitrogen (6.74 g. amino acid nitrogen and 2.25 g. peptide nitrogen) and 582 calories. Oral feeding was begun on the 3rd day after operation and was increased so that the patient's protein intake never fell below 57 g. protein per day. Nitrogen equilibrium was thus possible by the 6th day, on an intake of 93 protein and 2,112 calories. The net nitrogen losses for the first six post-operative days were only 51.06 g. nitrogen. Of the nitrogen administered, approximately 90% of the amino acid nitrogen and 47% of the peptide nitrogen was metabolised, i.e. a minimum of 68% of the total nitrogen of the Amigen had been metabolised. As with the patients receiving Casydrol, he was febrile during the administration of the Amigen and remained so for another 4 days. He lost 6 lb. in weight after /

after operation. Despite the Amigen solution having a pH of only 5.26 the patient showed no signs of acidosis and his carbon dioxide combining power remained constant at about 66 vol.%.

The quantities of Amigen administered were smaller than those of Casydrol, which makes a comparison of the two infusions difficult. Nevertheless the impression is gained that in this particular case the Amigen had been both metabolised and utilised to a greater extent than was the Casydrol in the 4 cases quoted. Further investigations are necessary before any definite conclusions can be drawn as to the relative merits of the two preparations.

There is little in the literature regarding the fate of protein hydrolysates after infusion. Those experiments that have been recorded deal only with the amino acid and peptide nitrogen which is excreted during and directly after short infusions on one particular day. Chritensen et al. (1946) gave 1 litre of 5% Amigen in 5% glucose to convalescing patients and recorded that the urinary losses during the period of infusion and succeeding hours included 36-53% of the peptide nitrogen and 2.4-6% of the amino acid nitrogen administered. Smythe et al. (1948), in a study of the effects of parenteral infusions of a 5% Amigen solution on 15 human subjects, showed /

showed that losses of 1.6-19.7% of the total amino acid nitrogen given occurred in the 4 hours following the infusion, the majority of which occurred in the peptide form. The Casydrol studies were in agreement with these findings, that the peptide nitrogen is less readily used by the tissues and more poorly retained by the kidneys than is the free amino acid nitrogen.

In the medical cases discussed, there was apparently better utilisation of the Casydrol than was found in the surgical cases. It is possible that this discrepancy in the results is due to the fact that the medical cases were poorly nourished. Silber et al. (1946), in experiments with dogs, has shown that after the administration of a mixture of amino acids that the loss in the urine of amino acids is considerably less if the dog has been on a low protein diet. If the protein depletion was relieved then the urinary amino acid loss rose to normal limits.

The human body's ability to remove quickly the amino acids infused is demonstrated by the constancy of the amino acid levels. Some raised values were observed during the first 2 hours of the infusion but after that, despite the continuation of the infusion, levels within the normal range were recorded.

Plasma./

Plasma.

Surgical trauma is often accompanied by a fall in the circulating plasma volume and by hypoprotein--emia so that the giving of plasma infusions after operation would seem a logical procedure. Browne (1944) has in fact shown that in surgical patients positive nitrogen balances can be obtained as the result of plasma infusions. Evidence has also been obtained, however, which indicates that the injected plasma protein rapidly disappears from the circulat--ion and that approximately 50% is retained in the body and re-made into tissue protoplasm, while the other half appears in the urine as urea and ammonia (Albright 1947). The process of tissue production is a slow one so that the increased nitrogen excretion may not occur until 10-20 days after the infusion has stopped. A positive nitrogen balance immediately after a plasma infusion does not there--fore necessarily indicate that the utilisation of the plasma proteins has occurred.

Attempts were made to see if plasma proteins given parenterally could be utilised by 2 partial gastrectomy patients (Case Nos. 41 and 42), and if positive nitrogen balances were obtained in the immediate post-operative period, whether they would be followed at a later time by a period of increased nitrogen /

nitrogen excretion. The effect of the infusions on the patients' own plasma protein levels was also to be examined.

The patients received pooled plasma, which had been freshly filtered on the day prior to the infusion. Nitrogen analyses were carried out on specimens withdrawn from each of the bottles of plasma given, so that the exact amount of nitrogen the patient received could be calculated.

One of the patients (Case No. 41) received 770ml. plasma (6.1 g. nitrogen) and 935 ml. plasma (6.98 g. nitrogen) for the first 2 days after operation, and then the infusions had to be stopped on account of thrombosis. No assessment of the effect of the infusions could therefore be made.

The second patient (Case No. 42) died after receiving 1,555 ml. (7.1 g. nitrogen), 400 ml. (1.66 g. nitrogen), 800 ml. (2.27 g. nitrogen), 1,775 ml. (9.01 g. nitrogen) and 1,670 ml. (10.26 g. nitrogen) plasma on 5 successive days. The amounts given were not sufficient to have any effect on the urine nitrogen excretion, which was as usual increas--ed, and so again no conclusions could be drawn.

No further investigations into the value of this type of parenteral protein feeding were made, as the risks incurred were not considered to be justifiable.

<u>THE</u> /

THE USE OF MILK MIXTURE IN THE FEEDING OF SURGICAL PATIENTS.

It has been suggested that the lack of success achieved with parenteral feeding has been due in part to deficiencies in the caloric intake of the patients. It was found impossible to increase this intake appreciably above the levels mentioned in the preceding section by parenteral means, so that feeding by intubation offered a possible alternative which seemed worthy of examination. The protein hydrolysate preparation, Pronutrin, has proved to be unsatisfactory when given in this manner on account of its secretagogue activity, and so the following investigations were made using a milk mixture, which could be prepared to contain adequate amounts of both protein and calories.

Intrajejunal feeding has been used fairly extensively in the preparation of poorly nourished patients for operation, and in most instances dried skimmed milk powder has been used as the protein concentrate, and given in a mixture of milk, sugar and eggs (Varco 1947). Stewart et al. (1948) have used a mixture containing casein, yeast, trypsin, sucrose, vitamins and salts, which they consider to be satisfactory /

satisfactory as it fulfils the following requirements: (i) It provides an adequate diet, (ii) it is fluid enough to drip by gravity through a small catheter without sedimentation, (iii) it is approximately neutral in reaction, (iv) it is inexpensive, easily prepared, capable of variation and can be kept for 48 hours in a refrigerator and (v) it is easily digested and absorbed and yields a low residue.

The mixture used for this group of 6 patients after partial gastrectomy conformed to Stewart's criteria and had the following composition:-

180 g. dried skimmed milk,

900 ml. milk,

150 g. lactose,

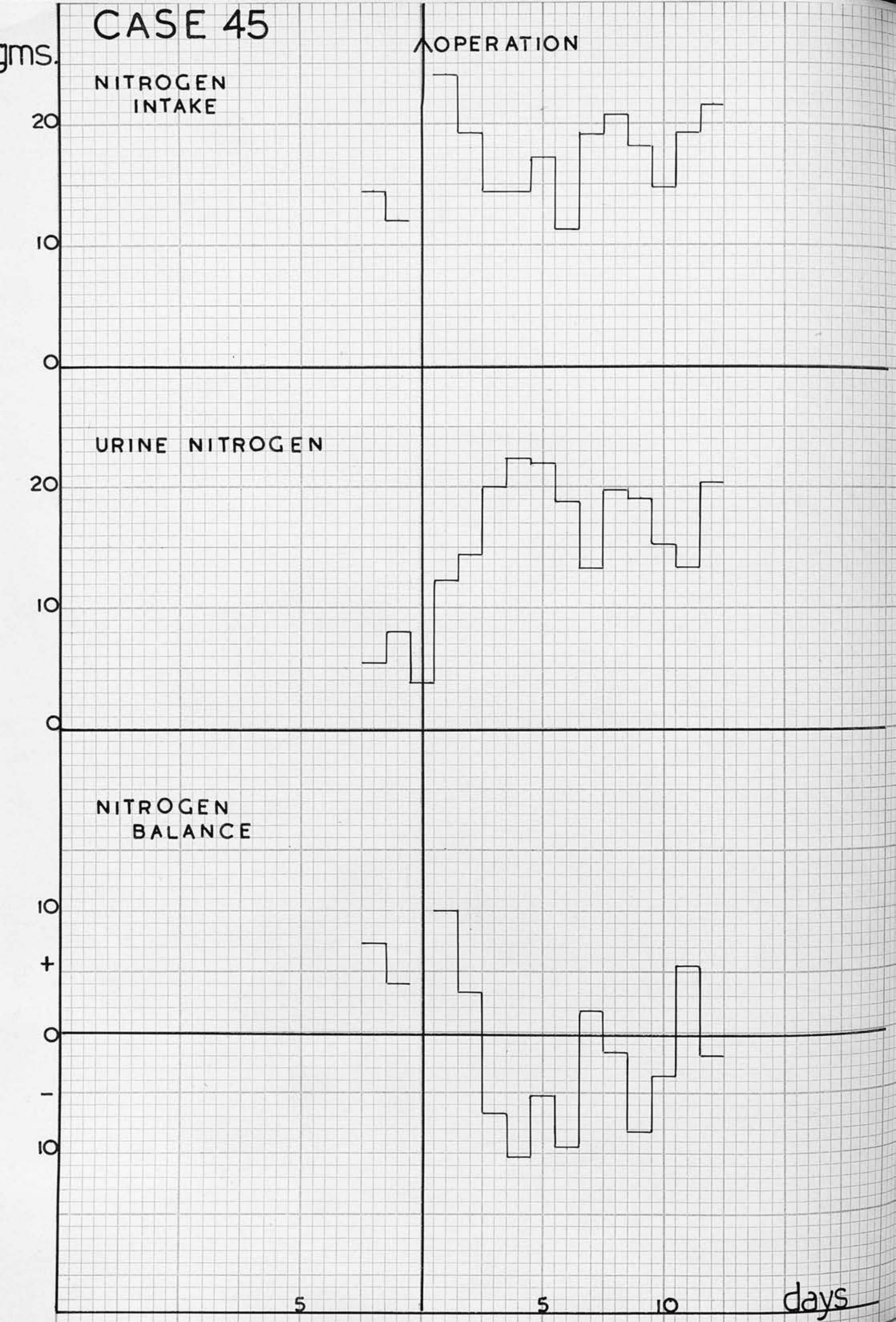
Water to 1800 ml.

The above quantities are the minimal amounts it was aimed at giving the patients, since they contained 90 g. protein and 1,795 calories, but in some instances they received more. A double lumen tube was inserted into the jejunum at operation, and feeding with the milk mixture was begun on the day of operation. For the first 2-3 days the mixture was given in 2-hourly feeds through the tube, but as soon as possible it was taken by mouth as a supplement to the ordinary food. The patient thus received a reasonably constant intake of food throughout the post-operative period.

The /

The nutritional adequacy of the mixture was clearly indicated by the fact that a patient (Case No. 43), awaiting operation for oesophageal ulceration and stenosis, improved in health while receiving the mixture for 50 days as his sole source of nourishment. The amounts of the milk mixture given to the patient (Appendix) were slightly greater than those given to the gastrectomy patients as for 33 days he received 119 g. protein and 2,386 calories per day; this intake was then raised to 128 g. protein and 2,581 calories. On both regimes he remained in positive nitrogen balance (average 2.93 g. nitrogen per day). Some fluctuations in weight were observed probably due to water retention, but no gross losses occurred, and after 50 days on the diet a net increase of 2 lb. in weight was recorded. Faecal analysis showed that 90% of the nitrogen in the food had been absorbed. The total plasma protein concentration rose from 5.31 g.% to 6.28 g.%, the improvement being mainly in the albumin fraction, and then later fell to 5.73 g.%; this fall may possibly be due to changes in the plasma volume and may not necessarily indicate any variations in the total circulating plasma proteins.

The supply of milk mixture for 1 day had an approximate salt content of 6.39 g. and for the first /


CASE 45
gms.
OPERATION
NITROGEN INTAKE
20
10
0
URINE NITROGEN
20
10
0
NITROGEN BALANCE
10
+
0
-
10
5
5
10
days

first 11 days 20 g. salt was added to the milk mixture, which accounts for the very large amounts of salt appearing in the patient's urine (13.3-34.8 g. per day). The additional salt intake was then cut to 10 g. per day and for the last 11 days no salt was added to the milk mixture.

<u>Case No. 44</u> (N.B.) Aged 52; Occupation, guide at Holyrood Palace.
Diagnosis - chronic duodenal ulcer and pyloric stenosis.
Operation - partial gastrectomy.

Milk mixture feeding was begun on the day of operation and continued for 5 days. For the first 3 days after operation his intake varied from 40-70 g. protein and a small negative nitrogen balance was recorded, but on the following 2 days it was raised to 119 g. protein and the patient was in nitrogen equilibrium. The cumulative nitrogen losses for the 6 days after operation were only 11.76 g. nitrogen. The patient's debilitated condition resulting from the stenosis prior to his operation may have partly accounted for this lack of a catabolic response, though the extra feeding no doubt also had its effect.

<u>Case No. 45</u> (J.S.) Aged 52; Diagnosis - chronic duodenal ulcer;
Operation - partial gastrectomy.

This patient was given a day's supply of milk mixture on the day of operation and on the 2 days following he received amounts containing 150 and 119 g. protein, and as a result there was nitrogen retention. On decreasing the intake level to 90 g. protein and 1,795 calories, however, the nitrogen excretion exceeded the intake, and there was a period of negative nitrogen balance. His normal diet was supplemented with milk mixture drinks for a further 8 days, so that the protein intake varied from 93-134 g. protein per day. For 3 of these days negative nitrogen balances were recorded due to excessive nitrogen losses in the faeces resulting from diarrhoea. Of the protein taken in the diet during the /

the 8 days mentioned, only 79% was absorbed and available for utilisation. It appeared as if the patient could only absorb the milk mixture properly for a limited period of time.

Case No. 46 (R.H.) Aged 43; occupation, P.O. engineer.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

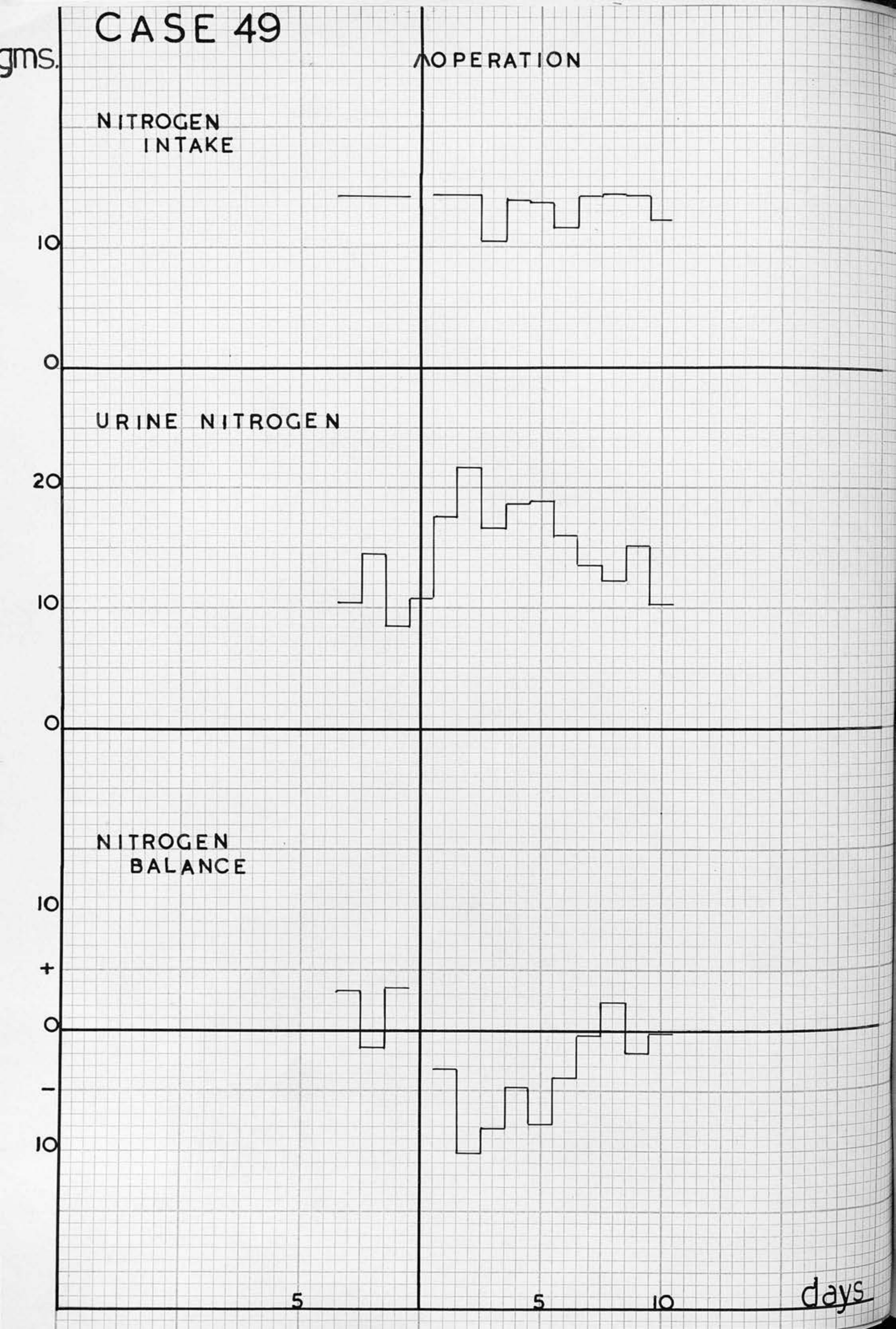
Milk mixture feeding was begun on the day of operation, and for the next 6 days the patient received a constant intake of 90 g. protein and 1,795 calories. In spite of a very adequate fluid intake the urine volumes for the first 3 days were only 505, 300 and 820 ml. respectively, and the amounts of nitrogen excreted were lower than normal, with the result that positive nitrogen balances were recorded. On the next 5 days, however, the urine nitrogen excretion increased and there was definite evidence of a catabolic phase having occurred. During the period of milk mixture feeding the patient was troubled with diarrhoea so that, of the protein given, only 68% was absorbed and available for utilisation.

Case No. 47 (J.L.) Aged 52; occupation, railway linesman.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient was given 60 g. protein and 1,195 calories in the form of milk mixture on the day of operation and for the next 5 days received amounts which provided him with 70-90 g. protein and 1,395-1,795 calories per day. Although an apparently well nourished man before his operation, he was in negative nitrogen balance for only 3 days, so that his net nitogen losses for the 6 days after operation amounted to approximately 17 g. nitogen (specimens lost on 5th day). This patient remained afebrile during the investigation and had no difficulty in absorbing the nitrogen from the milk mixture.

Case No. 48 (W.S.) Aged 53; occupation, colliery foreman.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

This patient only received the milk mixture on the day of operation and on the following 2 days as the tube did not stay in position and he was unable to /



CASE 49
gms.
OPERATION
NITROGEN
INTAKE
10
0
URINE NITROGEN
20
10
0
NITROGEN
BALANCE
10
+
0
−
10
5
5
10
days

to tolerate such large quantities by mouth. With the exception of the second day when the tube was removed, he was able to maintain a fairly constant level of protein intake, and his net negative nitrogen balance for the 6 days after operation was 42.31 g. nitrogen.

Case No. 49 (D.T.) Aged 37; occupation, chemical engineer.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

Feeding was begun on the day of operation for this patient. On the next 2 days he was given the milk mixture by intubation, and then for the following 3 days he took the mixture by mouth in addition to ordinary food. His daily nitrogen intake, therefore, only varied between 10.40 and 14.28 g. nitrogen per day in the post-operative period. For the 5 days after operation he was in negative nitrogen balance to the extent of 34.03 g. nitrogen. The patient had no apparent difficulty with the absorption of the milk mixture.

A comparison of the results obtained from the patients receiving milk mixture (Table 9) with those in the group who were given the normal ward routine diet (i.e. semi-starvation) after partial gastrectomy had been performed clearly indicates that this type of feeding has caused a considerable reduction in the net losses of nitrogen. In the control group of 7 patients, values for the sum of the net negative nitrogen balances for the 6 days after operation, ranged from 38.99-93.9 g. nitrogen, whereas in the group of 6 patients receiving milk mixture the range for a similar period was 11.76-42.31 g. nitrogen. Positive nitrogen balances were not generally recorded but /

TABLE 9.

Effect of Milk Mixture Feeding on Nitrogen Balance.

Case No.	Post-op. N Balance g./day	Post-op. N Intake for 6 days g.	Net Neg. N Balance for 6 days g.	Length of Neg. N Balance days.
44	+ 1.70	78.90	11.76	3
45	?	100.24	27.72	4
46	+ 1.77	86.40	39.59	5
47	+ 3.68	81.30	17.00 (approx.)	3
48	+ 0.56	67.23	42.31	6
49	+ 1.75	78.40	34.03 (5 days)	5
Controls	Average	25.83	70.7	6.85
	Range	17.12-32.94	38.99-97.90	5-10

but there was some evidence to suggest that these might have been obtained with slightly higher intakes of protein. Riegal (1945) in a similar investigation gave his patients by intubation an average of 17.5 g. nitrogen and 1,750 calories per day in a mixture of milk, skimmed milk powder, eggs, cheese and soya bean flour. With these quantities he obtained positive nitrogen balances after cranial and gastric operations.

The quantity of protein given by intubation to gastrectomy patients was very largely limited by the patients capacity for taking fluid since it was not possible to obtain a homogeneous solution with higher concentrations of milk powder. With regard to the patients comfort 1,800 ml. appeared to be the maximum amount that could be tolerated so that intakes of over 90 g. protein (i.e. 14.4 g. nitrogen) per day were not practical. Although 2 of the patients had some difficulty in absorbing this quantity,the other 4 patients did not appear to have any difficulty with the digestion of whole protein. Once again, it is apparent that the patients' protein needs after operation are considerably increased, and that for nitrogen equilibrium, very much higher protein intakes than are normally required must be given.

TABLE 10.

Effect of Operation on Urine Chloride (as NaCl) Excretion.

Case No.	Group	Av. pre-op.	0	1	2	3	4	5	6	7	8	9	10
			Urine Chloride (As NaCl) in gramms. No. of Days after Operation.										
26	Volunt- -eers.	13.9	9.3	5.65	2.22	2.87	1.18	2.76	7.80	?	?	?	15.90
27		9.95	9.80	3.24	2.84	3.38	3.09	3.32	5.00	9.97	13.30	14.22	14.04
28A		13.10	4.10	3.44	4.06	5.80	8.90	5.53	8.55	9.58	6.76	17.40	10.00
29A		9.30	12.20	4.48	4.26	6.16	4.22	7.60	13.10	11.70	12.72	13.96	6.95
18	Con-	8.81	3.50	3.42	0.60	0.74	0.69	0.89	0.89	1.55	1.24	1.82	3.55
17	trols	4.86	.26	2.53	?	0.82	2.65	1.69	3.83	9.4	10.32	6.22	9.65
20	P.G.	8.20	2.04	4.37	3.42	0.80	1.23	1.86	2.80	?	?	?	6.25
19		6.12	7.04	7.03	2.28	1.29	2.72	6.13	8.16	7.79			
22	Misc.	6.84	2.64	0.80	0.79	0.07	0.07	0.93	1.39	4.08	6.48	4.69	4.90
23	surgic.	4.39	2.86	2.41	0.82	0.24	0.?0	3.00	3.02	2.59	7.72	3.60	4.80
24	cases	10.33	1.07	2.73	1.22	0.91	1.14	0.93	1.08	2.60	9.42	9.75	12.70
25		8.41	0.57	0.57	0.35	0.34	4.67	6.46	9.18	9.28	10.50	9.18	6.36
36	Casydrol	7.67	1.74	0.96	0.73	0.32	0.38	0.78	4.09	10.44	9.06	13.00	8.55
37		9.95	2.11	0.94	0.34	0.06	0.56	1.43	7.33	6.22	9.40	8.24	8.87
38		8.91	5.94	2.13	6.45	2.12	0.49	2.62	5.02	11.04	12.40	6.64	11.02
39		6.77	0.81	6.14	2.46	0.82	1.14	1.34	1.93	4.37	10.34	12.40	10.00
44	Milk	1.0	0.76	0.63	0.63	0.67	1.61	6.16	5.93	9.50	9.84	5.10	6.80
45	Mixture	7.74	2.51	1.18	2.23	1.56	4.10	6.20	4.50	4.25	7.36	6.71	6.93
46		1.64	1.44	1.74	0.16	0.38	0.35	0.86	0.77	2.20	1.95	0.77	?
47		6.30	0.57	3.97	2.73	2.03	?	2.91	4.42	4.92	7.82	8.03	8.59
48		10.18	1.38	5.70	5.18	2.26	1.32	1.33	1.47	2.06	6.16	4.21	7.98
49		10.36	2.43	1.87	1.68	0.94	3.49	7.13	?	5.30	?	5.66	6.12

SALT RETENTION AND THE PROTEIN CATABOLIC PHASE.

In the course of the investigations previously described, it was observed that, during the period of negative nitrogen balance, the excretion of chloride in the urine was much reduced below the amount found before operation and at a later period after operation. (Wilkinson et al. 1949). This depression of chloride excretion occurred irrespective of the amount of salt given. The time of onset of the depression varied but in most instances occurred abruptly on the day of operation, though in a few instances it was delayed for 1 or 2 days after operation. The depression lasted for 3 days in one patient, 4 days in four patients, 6 days in four patients, 8 days in seven patients and for 9 days or more in three patients. The total urinary chloride excretion (expressed as sodium chloride) fell below 1 g. per day for 2 or more consecutive days in nine patients, below 2 g. per day in five patients and in four patients it fell below 1 g. per day for 1 day. There was no relation--ship between the time of onset, duration or degree of depression of the urinary chloride excretion, and the type of post-operative treatment (Table 9).

Lack of salt intake is a possible explanation for the reduction in the urinary chloride excretion. The /

The classic experiment of Benedict (1915) has shown that fasting results in a gradual fall in the urinary chloride excretion to about 1.5 g. per day in 3 days, and that it continues at this low level until feeding is begun. This explanation will not, however, suffice in the case of patients on whom partial gastrectomy has been performed, since all such patients in this hospital receive saline infusions for 2-4 days after operation, which give them minimum intakes of 7.2 g. salt per day. Also in the studies on the volunteers (Case Nos. 26, 27, 28A and 29A) who received post-gastrectomy diets but no saline infusions, the lowest daily chloride excretions recorded were 1.18 g. on the 4th day (Case No. 26), 2.84 g. onthe 3rd day (Case No. 27), 4.26 g. on the 3rd day (Case No. 28A) and 3.44 g. on the 2nd day (Case No. 29A) and were probably due to lack of intake. In no instance was there a sudden drop in the chloride excretion on the 1st day, nor were levels of less than 1 g. per day attained, which suggests that some factor other than lack of salt intake was responsible in the surgical patients for the depressed chloride excretion.

The chloride excretion of 4 of the patients in the control group who underwent partial gastrectomy (Case Nos. 17, 18, 19 and 20) was determined, and in all /

all these cases there was a depression of chloride excretion after operation in spite of intakes of more than 10 g. salt per day in some cases. These patients were treated with 2-hourly gastric aspirat--ions for periods of up to 4 days, so that losses of chloride in the fluid aspirated occurred, which in some instances amounted to 5 g. salt per day, though more usually they were only 1-2 g. per day. The degree of depression of the urinary chlorides appears to have been unaffected by the losses due to suction. Faecal excretion in the immediate post-operative period is usually negligible so that any chloride losses from the faeces have been ignored.

Similar results have been observed in the other 4 patients of this group who underwent operations other than partial gastrectomy. These patients did not receive intravenous infusions of saline, so that their salt intake was certainly low for a few days. That the fall in chloride excretion was not due to starvation was, however, indicated by the fact that in 2 of the cases excretions of less than 1 g.per day were recorded on the day after operation, and in the other 2 cases this level was reached in 2 days. The period of depressed chloride excretion coincided approximately with the period of negative nitrogen balance, /

balance, when the urine nitrogen excretion was maximal, so that there is no question of the urine volumes being inadequate for the chloride excretion. It is interesting to note that one of the patients (Case No. 23), whose protein catabolic response to operation was small due to his debilitated condition, did however have the usual depression in chloride excretion after operation.

In the group of 4 patients given intravenous infusions of Casydrol, high intakes of salt were maintained for 3-5 days after operation. In spite of this, the excretion of chloride in the urine fell to the low levels observed in the previous group, and returned to the pre-operative level only after the usual period of 5-8 days. It was noted in two instances that the urinary chloride excretion returned to the original level at a time when the chloride intake was lowest, because of the transition from intravenous infusion to oral feeding. This may have been due in part to the known delay in excretion of salt given intravenously (Moyer et al. 1947). Since the salt intake in the immediate post-operative period was known, it was possible to calculate /

calculate the chloride balances for these patients (Appendix). In spite of the large amounts of chloride removed in the gastric aspirations of 2 of these cases, considerable chloride retention was evident in all of these patients for a week after operation. This period of chloride retention again roughly coincided with the period of negative nitrogen balance, though it did not last so long in the patients (Case Nos. 36 and 37) where convalescence was delayed by phlebitis.

The pattern of chloride excretion in the group of 6 patients receiving milk mixture after operation was similar to that found in the preceding groups (Appendix). In 2 of the cases salt had been added to the milk mixture (which on an average provided 4.4 g. salt per day) so that net intakes of up to 19.88 g. salt per day were recorded. The chloride excretion, however, remained depressed; with the exception of one patient (Case No. 48), positive chloride balances were observed in the post-operative period. The urine chloride excretion after operation appears, therefore, to be unaffected by the diet taken after operation, or by whether the salt is given by the intravenous route or by mouth.

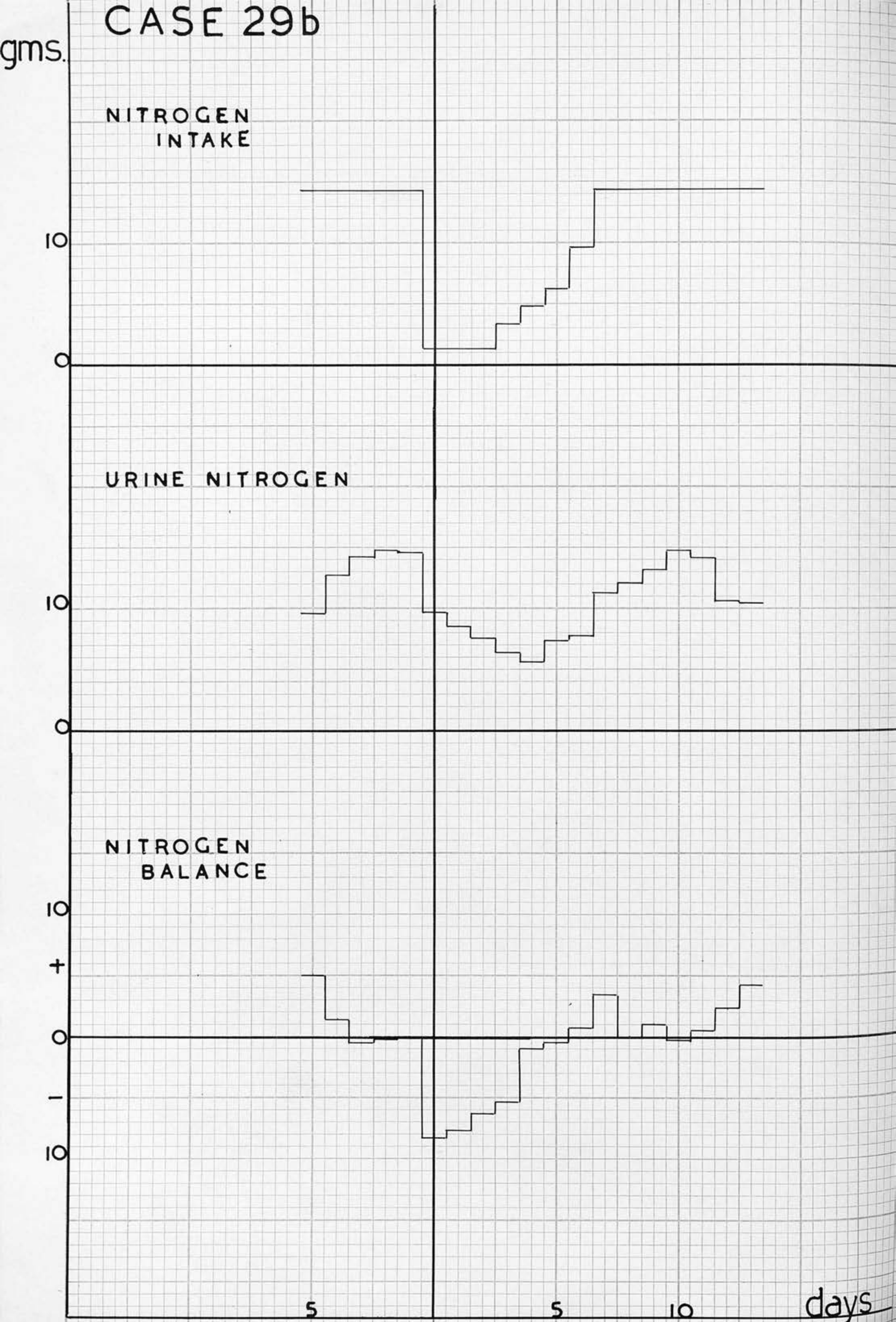
The /

The occurrence of a reduction in chloride excretion after operation has been previously observed and recorded (Matas 1924, Leguen 1933, Lambret 1933 and 1937, Robineau 1933, Bartlett 1938, Howard 1946 and Theron 1949). Little significance has been attached, however, to this observation and a more detailed examination of the changes in salt metabolism that occur as the result of surgical trauma seemed worthwhile.

<u>Sodium and Chloride balances in surgical patients given a constant Salt Intake</u>.

The following investigations were designed to see if the apparent retention of chloride after operation was accompanied by a similar retention of sodium, and what relationship this retention bore to the protein catabolic phase.

In the pre-operative period a diet of known nitrogen, sodium, chloride and caloric content was provided, and there was no addition of salt in cooking. The patient was supplied each day with a weighed quantity of salt which was sprinkled on to his food according to taste. An ample supply of distilled water was given and used to prepare tea and any other beverages; /



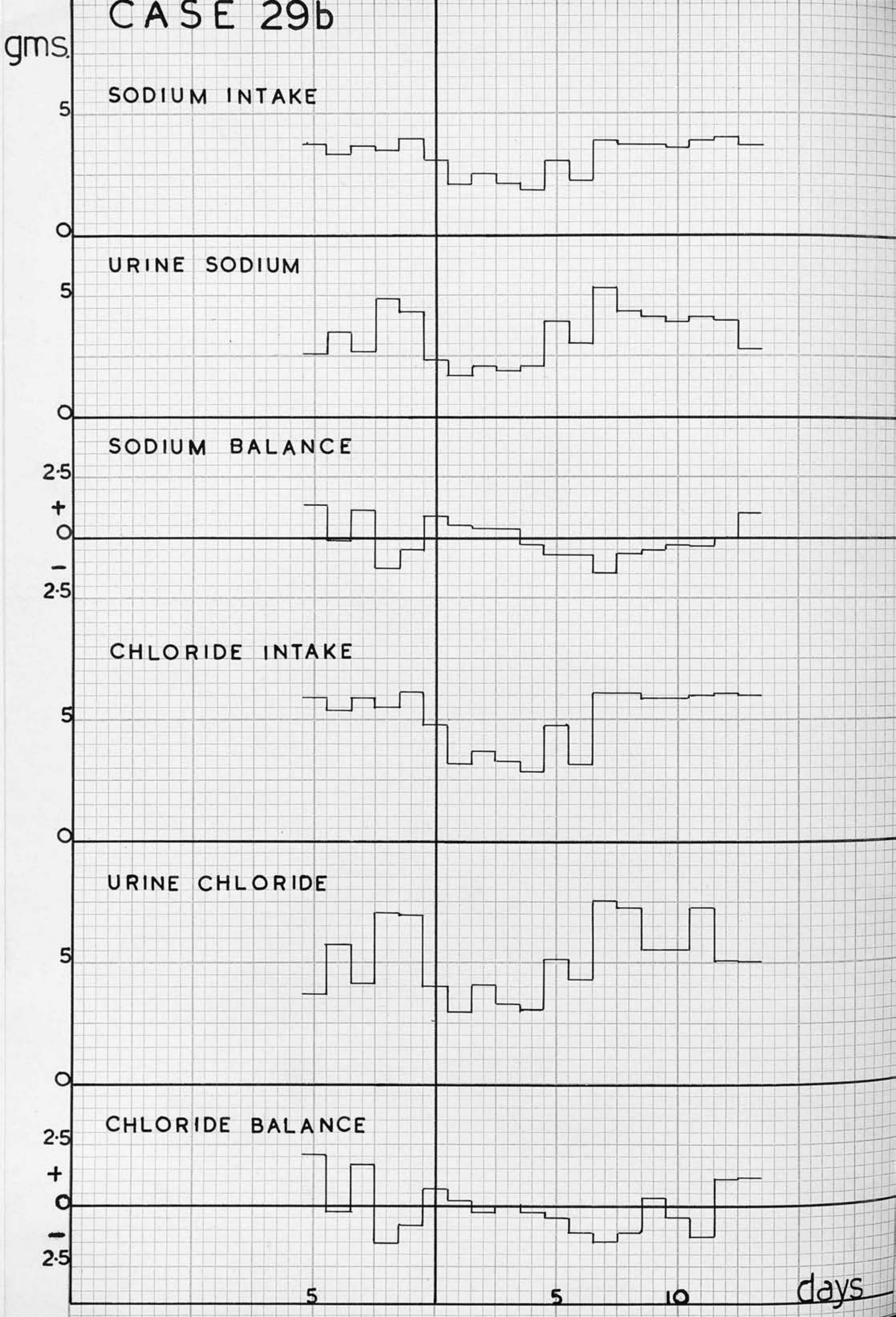
CASE 29b
gms.
NITROGEN INTAKE
10
0
URINE NITROGEN
10
0
NITROGEN BALANCE
10
+
0
−
10
5
5
10
days

beverages; the amount consumed was measured daily so that records of the total fluid intake could be kept. Before normal feeding had been re-established and after saline infusions had been discontinued, the requisite amount of salt was given by mouth so that an intake of 6-8 g. salt per day was maintained throughout the investigation.

Nitrogen balance studies were also made in all of the following cases and it will be seen that the results recorded are very similar to those of the control group of patients previously discussed, as both groups received the normal ward gastrectomy diet, and were given no protein supplements. In the sodium and chloride balance studies made on the 3 volunteer subjects and on 4 of the patients, no analysis of salt lost in the faeces was made. Estimations of the faecal salt losses were, however, included in the balances of 4 other patients, one of whom was given Amigen infusions after operation. No allowances were made for losses due to perspiration.

Case Nos. 28B, 29B. and 30.

After 6 days on a fixed diet the 3 medical students were given a diet equivalent in protein content to that given to gastrectomy patients after operation, though, for reasons previously discussed, the /



CASE 29b
gms.
SODIUM INTAKE
5
0
URINE SODIUM
5
0
SODIUM BALANCE
2·5
+
0
-
2·5
CHLORIDE INTAKE
5
0
URINE CHLORIDE
5
0
CHLORIDE BALANCE
2·5
+
0
-
2·5
5
5
10
days

the caloric content was maintained at a level of 2,500 calories. The salt intake was kept constant and nitrogen balance studies were made to ascertain if reductions in protein intake per se were to any extent responsible for salt retention.

In all 3 cases the urinary sodium excretion ran almost parallel to the chloride excretion, so that a period of positive sodium balance was usually accompanied by a period of positive chloride balance. On account of slight differences in intake, equivalent amounts of sodium and chloride were not necessarily excreted in the urine, but the sum of these differences over a period of 7 days on a fixed diet was negligible.

One of the students (Case No. 28B) was in negative nitrogen balance prior to the period on the gastrectomy diet and lost weight, so that it was to be expected that negative sodium and chloride balances would be recorded in his case. The other 2 students were more or less in balance during the preliminary period.

Negative nitrogen balances were recorded for the 6 days that the protein intake fell below 60 g. per day for each of the students. During this time small net positive sodium balances and, in2 out of 3 cases, positive chloride balances were found. The sodium retention was shown to be relatively greater than the chloride retention at this time by calculat--ing the differences in the positive balances obtained, expressed as milliequivalents (Table 14).

This period of salt retention was followed by a period in which the salt excretion exceeded the intake, and relatively more chloride was excreted than sodium. No correlation between salt retention and the fluid balance could be found.

There is, therefore, some evidence to suggest that a part of the chloride retention previously described may have resulted from a decrease in the nitrogen intake. Other factors must, however, be involved since chloride retention was also observed in patients fed with milk mixture immediately after operation. /

TABLE 11.

For 6 days of Neg. N. Balance.

Case No.	Net Na.Retention g.	Net Cl. Retention g.	Na-Cl. Balances meq.
28B	+3.96	+3.23	+62
29B	+1.02	-0.05	+43
30	+1.49	+1.10	+34

operation.

The lowest urine chloride excretions (expressed as sodium chloride) recorded during the period of restricted protein intake were 6.22 g. (Case No. 28A), 4.83 g. (Case No.29A) and 7.20 g. salt (Case No. 30), with daily salt intakes of 8.72 g., 5.31 g. and 9.92 g. salt respectively. The salt, but not the protein, content of the diet has been the controlling factor in the amount of salt excreted in the urine.

(Positive balances of 0.25 g. sodium and 0.4 g. chloride per day or more were considered to indicate sodium and chloride retention.)

Case No. 50. (J.I.) Aged 58; occupation, labourer.
Diagnosis - chronic duodenal ulcer.
Operation - posterior gastroenterostomy.

For 6 days before his operation, this patient was in positive balance for nitrogen (average 2.55 g. per day), sodium (approximately 1.45 g. per day) and chloride (approximately 2.44 g. per day). Estimations of the salt lost in the faeces were not made but as the faecal nitrogen excretion was normal it was unlikely that more than 0.3 g. salt per day would have been lost in this way. The fluid balance records did not indicate that there had been any excessive water retention so that the reason for this salt retention is unknown. During the preliminary period sodium and chloride were excreted in approximately equivalent amounts. Owing to differences in the amount of salt taken with the food, the daily sodium and chloride intakes varied from 2.16 - 3.86 g. sodium and 3.37 - 6.14 g. chloride.

After operation, with the exception of the first day, there was both sodium and chloride retention, with average positive balances of 1.48 g. sodium and 1.98 g. chloride per day. This retention lasted until the 7th day and so lasted 2 days longer than the nitrogen catabolic phase. Relatively more chloride than /

than sodium was excreted for the first 6 days after operation, after which the relative chloride excretion exceeded the sodium excretion. The daily salt intake remained fairly constant during the immediate post--operative period, but then dropped owing to the patient's refusal to take sufficient salt with his food.

Case No. 51. (W.S.) Aged 36; occupation, miner.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

In the pre-operative period this patient was in positive balance for nitrogen (average 3.21 g. per day), sodium (average 0.65 g. per day) and chloride (average 1.12 g. per day). The sodium and chloride were excreted in the urine in approximately equivalent amounts.

For 7 days after operation there was an average daily retention of 1.33 g. sodium and 2.42 g. chloride. This was followed by a period of negative balance for both ions for 4 days, and then a further period of salt retention occurred. Sodium and chloride were retained in equivalent amounts for the first 3 days, but for the next 7 days relatively more sodium than chloride was excreted in the urine, and on the following 4 days more chloride than sodium appeared in the urine. The period of negative nitrogen balances lasted for 8 days and so coincided with the period of salt retention. A second catabolic phase which occurred 2 days later was not, however, accompanied by salt retention, though small positive balances for both salt and nitrogen were recorded later.

Case No. 52 (P.R.) Aged 54; occupation, furnace worker.
Diagnosis - chronic duodenal ulcer.
Operation - vagotomy and antrectomy.

This patient was in nitrogen equilibrium for 6 days before his operation. On the 2nd, 3rd and 4th days he was treated with "Sippy" powder which added considerably to his sodium, but not his chloride, intake; his sodium retention for these 3 days was therefore considerably greater than his chloride retention, though the excess sodium retained was excreted /

excreted during the following 2 days.

On the day after operation the sodium and chloride losses exceeded the intake, but for the next 6 days there was a period of both sodium and chloride retention (average 0.89 g. sodium and 1.86 g. chloride per day), in which relatively more chloride than sodium was retained. Negative nitrogen balances were recorded for 5 days, followed by a period of both nitrogen and salt retention, though the latter was not as great as that found after operation. For the first 5 post--operative days relatively more chloride than sodium was retained; On the following 4 days this position was reversed and the amounts of chloride in the urine were relatively greater than those of sodium. For the remainder of the investigation both ions were excreted in approximately equivalent amounts.

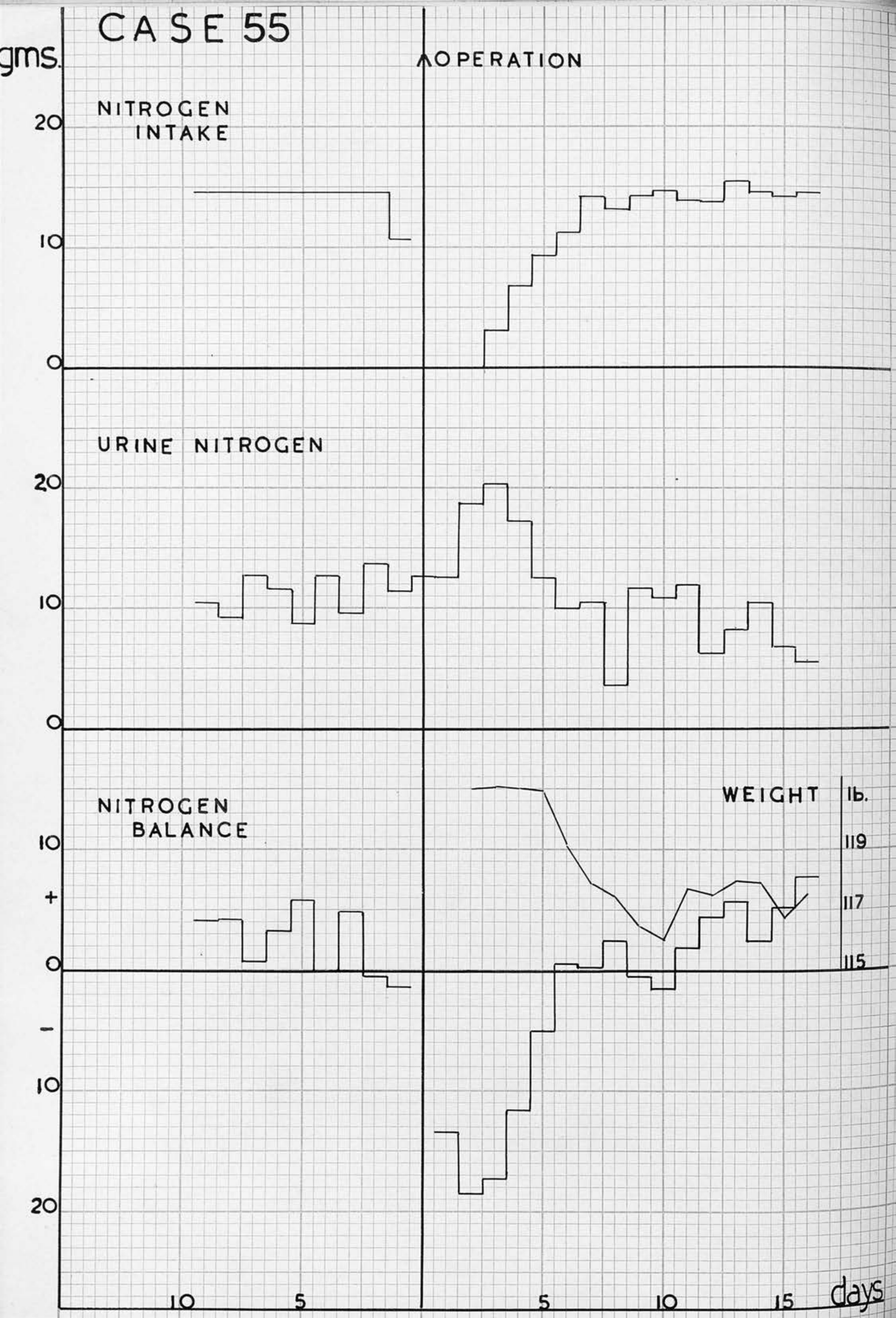
<u>Case No. 53</u> (T.L.) Aged 63; occupation, farm-worker.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

Although in positive nitrogen balance (average 1.06 g. per day) before his operation, this patient was in negative balance in respect of both sodium (average 1.02 g. per day) and chloride (average 0.90 g. per day) and was losing relatively more sodium than chloride in his urine.

Negative nitrogen balances were found for 5 days after operation. On the first day, large amounts of both sodium and chloride were excreted in the urine, but by the 2nd day the urinary excretions of these two ions had dropped to 0.78 g. and 1.30 g. respectively. Unfortunately the salt intake for the next 2 days was very small and, as a result, small negative sodium and chloride balances were recorded. Resumption of the salt intake resulted in sodium and chloride retention for the next 7 days, though the patient was in nitrogen equilibrium after the first of these days. Over the 6 days after operation an average of 0.79 g. sodium and 1.44 g. chloride was retained. For 9 days after operation relatively more chloride than sodium was excreted in the urine.

<u>Case 54</u> (D.M.) Aged 51; occupation, barman.
Diagnosis - chronic duodenal ulcer.
Operation - vagotomy and antrectomy.

Before his operation this patient was in positive balance in respect of nitrogen (average 4.33 g. per day) sodium /


CASE 55
gms.
OPERATION
NITROGEN INTAKE
20
10
0
URINE NITROGEN
20
10
0
NITROGEN BALANCE
WEIGHT
lb.
10
119
+
117
0
115
-
10
20
10
5
5
10
15
days

sodium,(average 0.31 g. per day) and chloride (average 0.51 g. per day). After the cessation of the saline infusions, the orange juice salt mixture was not given until the 4th day. The level of salt intake therefore fell from 2.54 g. sodium and 3.92 g. chloride on the first day to 1.41 g. sodium and 2.17 g. chloride on the 2nd day, and to 0.54 g. sodium and 0.92 g. chloride on the 3rd day, so that it was not until the 4th day after operation that sodium and chloride retention was observed. This period of salt retention lasted for approximately 5 days and was maximal on the 7th day after operation, whereas the period of negative nitrogen balance lasted for only 6 days. Throughout the investigation the urine contained approximately equivalent amounts of sodium and chloride.

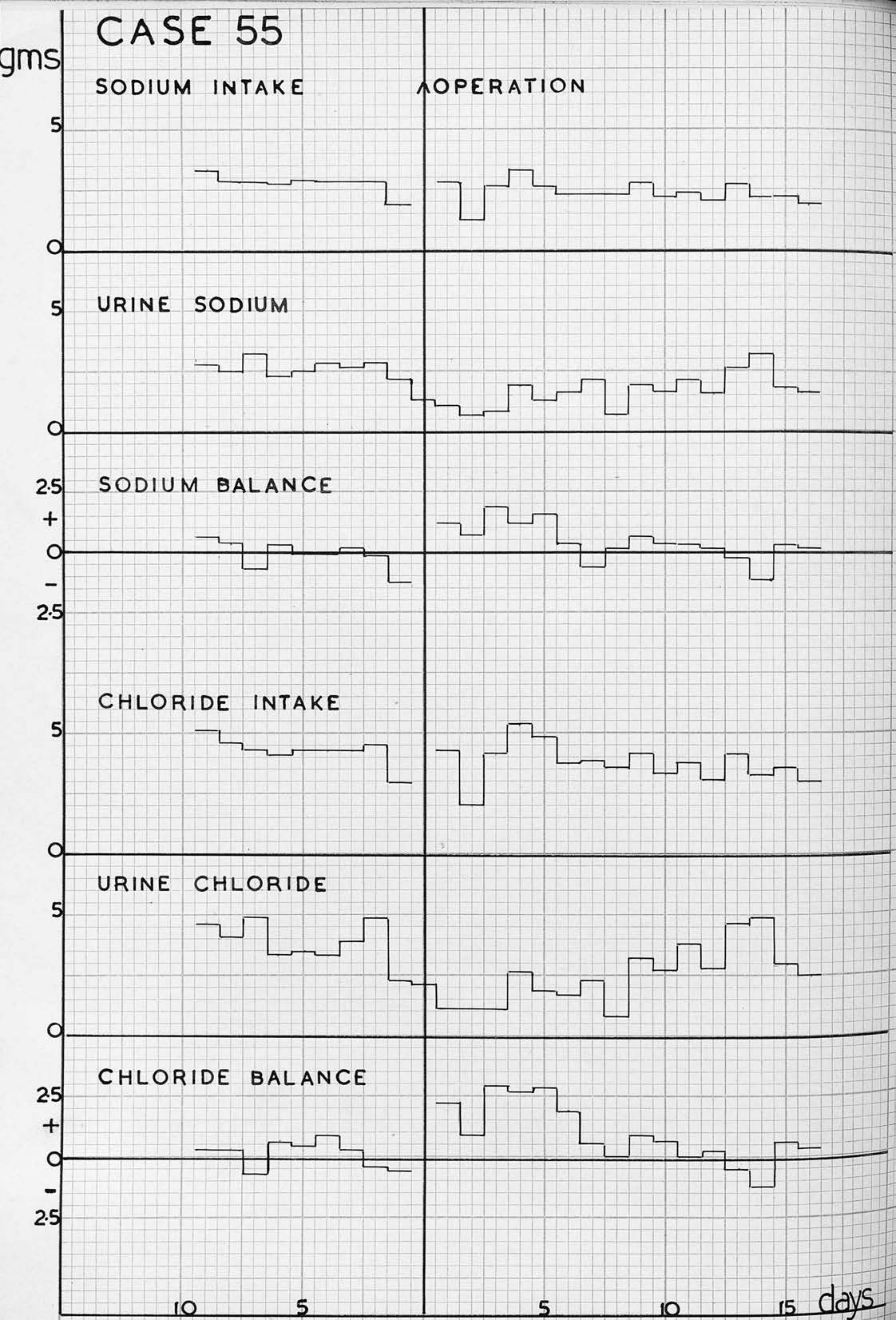
Case No. 55 (A.S.) Aged 43; occupation, barman.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

In this case all excretions and gastric aspirations were analysed for nitrogen, sodium and chloride, and potassium, phosphorus and sulphur determinations were carried out on the urine but not the faeces.

For a week before operation the patient was retaining nitrogen (average 2.38 g. per day) and was in equilibrium in respect of sodium (average .05 g. per day) and chloride (average 0.14 g. per day). After operation there was retention of sodium (average 1.11 g. per day) and chloride (average 2.26 g. per day) for 6 days, which coincided with the period of negative nitrogen balances which lasted for 5 days. Relatively more chloride than sodium was retained for the first 7 days after operation, after which equivalent amounts of the two ions were excreted in the urine.

Estimations of potassium in the urine indicated that the patient was retaining potassium prior to operation. On the day of operation there was a potassium diuresis and the urine potassium excretion rose from an average of 2.66 g. per day to 4.1 g. On the following two days, in spite of the intake being nil, the potassium excretion continued at a level of 2.18 g. per day. It then dropped to 0.33 g. per day in 6 days, after which it remained at a level of 1.30 g. per day; this indicated that a considerable amount of the potassium in the food must have been retained as losses in the faeces would be unlikely to have amounted to more than 0.3 g. per day.

The /


CASE 55
gms
SODIUM INTAKE
OPERATION
5
0
URINE SODIUM
5
0
SODIUM BALANCE
2·5
+
0
-
2·5
CHLORIDE INTAKE
5
0
URINE CHLORIDE
5
0
CHLORIDE BALANCE
2·5
+
0
-
2·5
10
5
5
10
15
days

The urinary phosphorus excretion ran parallel to that of the potassium though the final level of urine phosphorus excretion was the same was that found pre--operatively. Lack of faecal analysis made the assessment of a balance for phosphorus impossible, but it appeared as if the patient was only in negative balance in respect of phosphorus for 2 days after operation, and that this was followed by a period of positive balance.

Values for the ratio of nitrogen to sulphur excreted in the urine varied between 11.9 and 21.4 with an average balance of 15.2 for the pre-operative period, 15.88 for the immediate post-operative period and 16.63 for the following 10 days.

<u>Case No. 56</u> (F.S.) Aged - Occupation, hairdresser.
Diagnosis - chronic duodenal ulcer.
Operation - partial gastrectomy.

Estimations of the nitrogen, sodium, chloride, potassium, phosphorus and sulphur contents of the urine, faeces and gastric aspirations were made. Before operation the patient was in positive balance for nitrogen (average 2.48 g. per day), sodium (average 0.19 g. per day), chloride (average 0.65 g. per day), potassium (average 1.05 g. per day), phosphorus (average 1.21 g. per day) and in slight negative balance for sulphur(average 0.08 g. per day).

The period of negative nitrogen balances after operation lasted for 6 days. On the first day after operation both the sodium and chloride excretion exceeded the intake, but for the next 3 days retention of both ions occurred. The studies could only be continued for a further 3 days, during which time the patient was more or less in equilibrium for sodium and chloride, so that for the first 6 days an average of 0.49 g. sodium and 1.23 g. chloride each day were retained. After operation relatively more chloride than sodium was retained.

The urinary potassium excretion rose on the day after operation from an average of 1.96 g. per day in the pre-operative period to 2.82 g. per day. On all other days the post-operative potassium excretion was less than that found pre-operatively. Thus, with the exception of the 3 days after operation, when the potassium intake was nil for 2 days and then only 1.03 g. per day, positive balances were found, spite of losses in the faeces of up to 1.24 g. per day, which /

which amounted to 1.52 g. per day on an intake of 2.16 g. potassium.

The urinary phosphorus excretion remained very constant at a level of approximately 0.50 g. per day throughout the investigation, and was only raised on the day after operation when a value of 1.13 g. was recorded. The excretion of phosphorus in the faeces never rose above 0.46 g. per day, so that by the 5th day, when the intake had reached a level of 1.27 g. per day, positive balances were obtained.

For the pre-operative period the ratio of nitrogen to sulphur in the urine was 13.7; the value for this ratio fell to 10.7 and 12.3 for the 2 days after operation and then rose to 16.9 on the 4th day; by the 7th day, however, it was again within the pre--operative range. When small positive nitrogen balances were obtained it was noticed that the sulphur balances were slightly negative, which suggests that perhaps the values recorded for sulphur were too high, though recovery experiments with known amounts of sulphur gave satisfactory results.

Case No. 40.

In addition to the observations previously report--ed concerning this patient, a study of the effect of Amigen infusions on salt retention after operation was made.

The patient was in equilibrium for sodium and chloride before his operation. The urinary sodium and chloride excretion was depressed from the day of operation but owing to considerable losses in the gastric aspirations, negative chloride balances were recorded on the first 2 days. After this, both sodium and chloride retention occurred until the 7th day although the period of negative nitrogen balance only lasted for 5 days. Over the 6 days after operat--ion an average of 1.20 g. sodium and 1.56 g. chloride was retained per day. The period of salt retention was followed by 3 days in which negative sodium and chloride balances were observed. 100 ml. Amigen con--tains 85.5 mg. sodium and 85 mg. chloride so that it was to be expected that during the period of the infus--ion relatively more sodium than chloride would be retain--ed. This was followed by a period of 7 days in which relatively more sodium than chloride was excreted in the urine.

In /

In four of the cases of this group, the depression of sodium and chloride excretion after operation occurred on the day after operation, while in the other four cases it occurred on the second day. In the latter cases the urine volumes on the day of operation had been nil in two cases and 350 and 300 ml. in the other two, so that the urine passed on the day after operation might have included urine formed but not excreted before operation. In three of these four cases the sum of the intakes of salt for the day of operation and the day after approximately equalled the sum of the amounts excreted for these two days, so that there was no evidence of retention occurring until the second day after operation.

In all of the cases discussed sodium retention occurred at the same time as chloride retention, though the degree of retention of the two ions varied according to the individual and the time after operation. There was no general pattern of behaviour, but for the first two days after operation the relatively sodium retention usually exceeded the chloride retention; this was followed by a period lasting up to 7 days in which the amount of chloride retained was considerably greater than that of sodium. It was found, for the first 6 days after operations, that in five out of eight cases the sum of the chloride balances (in milli-equivalents) exceeded the sum of the sodium balances (in /

TABLE 12.

CASE No.	Net Neg. N.Balances for 6 days g.	Duration Prot. Cat. Phase, days.	Duration salt Retention days.	Net Na. Retention for 6 days g.	Net Cl. Retention for 6 days g.	Diff. in Na and Cl Retention meq.
50	49.4	5	7	8.88	11.85	+52
51	93.92	7	7	8.00	14.54	-61
52	79.29	5	6	5.34	11.19	-73
53	59.48	5	6	4.76	8.87	-43
54	42.18	6	7	6.34	9.65	+ 6
55	70.54	5	6	6.68	13.58	-92
56	47.79	6	3	2.97	7.35	-78
40	45.13	6	5	7.22	9.34	+48
Average Volunteers	21.63	5	3	2.24	1.46	+46

(in milliequivalents), so that 15-37% of the chloride retained had been in excess of sodium retained. In one case the relative amounts of sodium and chloride retention were almost identical, while in the other two cases, one of which had had a less severe operation while the other had been given Amigen, the initial period of excess sodium retention over chloride retention was extended so that the net balances for the 6 days indicated preferential retention of sodium (Table 11).

It is difficult to offer an adequate explanation for the differences in the relative amounts of sodium and chloride excreted in the urine. They may be associated with the destruction of tissue protein which occurs after operation and which contains in general more sodium than chloride (Darrow 1945).

It would be expected thatthe period of salt retention would be followed by a period of excessive excretion of both sodium and chloride. This was not observed in all cases, probably due to the fact that the investigations were not continued for a sufficient length of time.

The period of negative nitrogen balances started in all cases on the day after operation and lasted for 5 - 7 days. The salt retention began in 2 cases on the /

the day after operation, in 3 cases on the second day and in one case on the third day; regardless of which day it began, the period of salt retention lasted for as many days as the protein catabolic phase and in some instances 1 - 2 days longer. In 2 cases, owing to irregularities in maintaining the constant salt intake, it was found that the salt retention did not occur until the 4th and 5th day after operation; nevertheless, it lasted for 6 days, even though the patients were in nitrogen equilibrium during part of that time.

It appears, therefore, that salt retention and protein catabolism, although both result from the trauma of operation, are two quite independent responses, which may, if an adequate salt intake is given, occur at the same time.

De Wesselow (1924) has stated that for every 6 - 7 g. salt retained in the body there is an accumulation of 1 litre of water. Fluid balance records were attempted for all the patients of this group, but in none of them was it possible to obtain a consistent enough balance in the pre-operative period to enable an assessment of the actual water retention after operation to be made.

A /

A reduction in the ability of the kidney to excrete salt in the immediate post-operative period has been observed by many workers (Matas 1924, Bartlett 1938, Discombe 1943, Coller 1940 and 1944, Marriot 1947). Coller et al. (1945) in a study of the salt excretion in the first 30 hours after operat--ion found that infusions of 3,500 ml. isotonic saline caused retention of 53% of the sodium and 46% of the chloride given, but only 19% of the water, which necessitated the withdrawal of water from the intra--cellular compartments. Robinson (1948) considers that the amount of salt retained is proportional to the load, with the urinary output remaining relatively fixed. Howard (1946) as the result of observations made on chronically ill patients fed by vein, is of the opinion that the degree of salt retention is proportional to the amount of operational shock. Campbell (1946) has shown that the rate of loss of sodium in the post-operative patient is not affected by glucose infusions.

Cuthbertson (1936), in his study of fracture cases, found that the urinary phosphorus and sulphur excretions fluctuated with the nitrogen excretion. A similar effect was observed in 2 cases after partial gastrectomy. The ratio of sulphur losses to nitrogen losses suggested /

suggested that, as with the fracture cases, catabolism of muscle tissue had occurred.

Both the cases on whom analyses of potassium in the urine were performed appeared to have considerable positive potassium balances both before and after operation. The amount of potassium retained was considerably in excess of that which would be expected from a knowledge of the nitrogen balances, assuming that on an average in tissue there is 1 g. potassium for every 10 g. nitrogen. On the day of operation and the 2 days following, the potassium excretion was higher than could be explained simply by tissue break--down. This indicated that there had also been a loss of intracellular potassium due to starvation and salt retention, which would necessitate an adjustment between intracellular and extracellular body fluids (Darrow 1945, Iob 1949). Both Cuthbertson (1936) and Howard (1944) have found similar increases in potassium excretion in fracture cases. Howard also found considerable positive balances for potassium, beginning 4 days after operation, which lasted for over 35 days, in five cases and totalled 663 - 1,155 m. Eq. The two investigations reported were not carried on for long enough to enable an estimate of the total

amount /

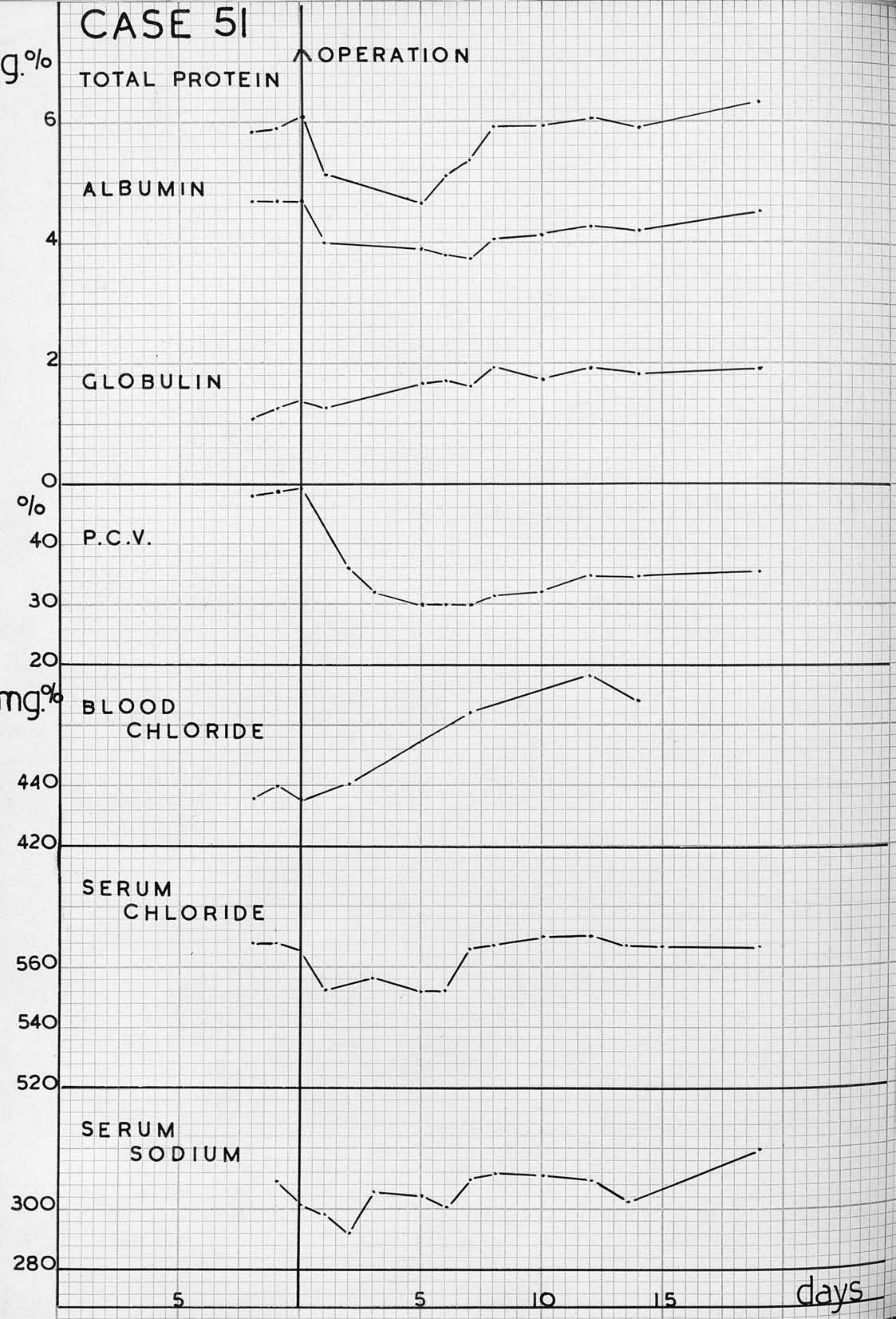
amount of potassium retained to be made, but it certainly appeared as if the amount would be considerable and it is planned to investigate this matter further.

CHANGES IN BLOOD CHEMISTRY FOLLOWING OPERATION.

Blood was withdrawn for analysis both before and after operation from the majority of patients, but only the 20 cases where blood was obtained on four or more occasions have been included in the Appendix, and used in this discussion. The time interval between the taking of the blood samples varied but in general at least one sample was taken before operation, one two days after, a third four days later and a fourth about a fortnight after operation; in some cases it was found possible to obtain more samples in the immediate post-operative period. The number of different types of estimation performed at any one time was limited by the amount of blood available. The changes that were observed in the blood chemistry as the result of operation appeared to be independent of the method of feeding employed and so will be discussed together.

Plasma Proteins.

The total protein concentration of the plasma was estimated in 16 cases and in each of these there was an immediate fall in concentration after operation. This depression continued for 2 - 12 days, depending on the individual, and ranged from 0.47 g.% to 1.5 g.% (average /


CASE 51
OPERATION
g.%
TOTAL PROTEIN
6
ALBUMIN
4
2
GLOBULIN
0
%
P.C.V.
40
30
20
mg.%
BLOOD
CHLORIDE
440
420
SERUM
CHLORIDE
560
540
520
SERUM
SODIUM
300
280
5
5
10
15
days

(average 0.83 g.%). The depression was almost entirely due to changes in the albumin fraction, which ranged from 0.25 g.% to 1.60 g.% (average 0.96 g.%). Only in 2 of the cases was there a fall in the globulin fraction of the plasma; in all other cases the globulin concentration rose to levels well above the pre-operative level. It is not known whether this rise in globulin concentration included an increase in the gamma globulin fraction; if so, it might have been the body's response to combat infection (Cannon et al. 1944).

Casten (1943) in a study of 26 cases, on whom gastrointestinal operations had been performed, also found falls in the total plasma protein concentration of more than 0.5 g.%. He could find no correlation between the type of anaesthesia given and the degree of the fall, which appeared to be greatest in the patients whose liver function was diminished. The suddenness of the fall of the plasma protein concentrat-ion cannot be explained simply by dilution of the plasma due to infusions of saline and glucose (Coller 1945) or by starvation, since it was not observed in the volunteers and Keys (1946) in his work on experimental oedema has shown that 6 months of semi-starvation only resulted in an average fall of 0.73 g.% in /

in 24 subjects.

Stewart and Rourke (1938) has shown that in 16 cases the plasma protein and blood sodium, chloride and haemoglobin concentrations did not fall immediately after major surgical operations, but that the blood volume was reduced and the thiocyanate space increased. There were, therefore, immediate changes in the total amount of circulating plasma proteins before the changes in plasma protein concentration became apparent, due to the removal of the blood in toto from the active circulation. In some preliminary studies on changes in blood volume and thiocyanate space after partial gastrectomy, these findings, regarding the lowering of the amount of total circulating plasma proteins, were confirmed. In one particular case, the plasma protein concentration before operation was 6.19 g.% (albumin 2.36 g.%, globulin 3.63 g.%), and the plasma volume 2,500 ml., which gave the total circulating protein as 154.5 g. (albumin 64 g., 90.8 g. globulin). On the day after operation the haematocrit reading rose from 31% to 38%, the plasma volume fell to 2,100 ml. and the total plasma protein concentration rose to 6.35 g.% (albumin 2.42 g.% and globulin 3.93 g.%); the total amount of circulating plasma protein had, however, fallen to 134 g. protein, due to losses of 12.3 g. albumin and 8.2 g. globulin. In 3 out of the 4 cases so /

so far observed, the decrease in the amount of circulat- -ing plasma proteins has been due chiefly to changes in the amount of circulating albumin. In the fourth case, the usual drop in plasma protein concentration was found,but not a decrease in the amount of circulat- -ing plasma proteins, due probably to the fact that the blood samples were not taken until 2 days after operation and by that time the plasma volume had risen above the pre-operative level.

To obtain a clear picture of the changes that are taking place in the vascular system after operation, a knowledge of both the changes in plasma concentration and plasma volume is therefore necessary.

Non-protein-nitrogen.

In 7 cases the non-protein nitrogen was determined, and in only 3 of these was a rise recorded; this rise was found to be due almost entirely to a rise in the blood urea nitrogen. Elevation of the blood urea nitrogen after operation was found in 4 out of 12 cases studied. Changes in the creatinine, uric acid and amino acid content of the blood were not significant. In contrast, other workers (Lambret 1933, Robineau 1933, Larget 1941) have reported moderate increases in non-protein nitrogen in all cases after operation. The plasma amino acid level appears, however, to remain /

remain constant after surgical procedures and acute illnesses (Christensen 1947, Grossman 1945, Kozall 1945).

Packed Cell Volume.

Haemo-concentration was observed in 4 cases out of 19 after operation. In 18 cases values for the packed cell volume dropped 3 - 16% (average 8.7%) in the post-operative period. In the majority, the lowest value was recorded between the 5th and 8th days, though in some cases it was not recorded until the 15th day after operation.

Red Blood Cell Count and Haemoglobin.

Changes in packed volume were accompanied by corresponding changes in the red blood cell count and the haemoglobin concentration. In 8 cases the depressions in the red blood cell counts ranged from 0.28 to 1.12 million R.B.C. per ml. blood (average 0.84 mill.). In 7 cases the falls in haemoglobin concentration varied from 8 to 24% (average 17.1%).

Carbon Dioxide Combining Power.

In spite of the shock of operation, the infusions given and the loss of fluid and chloride in the gastric aspirations, the carbon dioxide combining power remained remarkably constant throughout the pre-operative and /

and post-operative periods, which indicated that the patient's ability to maintain his acid-base balance was apparently unimpaired. In 16 cases, the average alteration in carbondioxide combining power was only 9 vols.%, and whereas in some cases there was an increase after operation, in other cases the carbon dioxide combining power was lowered. For all of these patients, the values recorded were within the normal range of 55 - 75 vols.%.

Blood Chlorides.

Blood chloride estimations were performed in 18 patients and in 5 of these no fall in chloride concent- -ration was observed. In 13 cases, however, depressions of 10 - 66 mg.% (as NaCl), - average 28 mg.%, from the pre-operative level were found, the lowest values being recorded about the 2nd day after operation. During the post-operative period the blood chloride concentration rose to a higher level than that previously observed.

Plasma Chlorides.

Plasma chloride estimations were performed in the 4 cases; it was found that they were slightly depress- -ed after operation and that later, higher values than those found pre-operatively were recorded. These findings are in agreement with those of Lambret (1933), Robineau and Leguen (1933), and Theron and Wilson (1949).

Labby /

Labby and Hoagland (1947) found similar changes in patients with liver disease, which they attributed to increases in the thiocyanate space. This explanation may apply after surgical operations since increases in thiocyanate space have been observed in the 4 cases so far investigated. The plasma chloride depression occurred at the same time as the period of salt retention and did not necessarily indicate that there had been a deficiency of salt after operation; this point has been discussed in detail,by Abbot (1946).

The French workers, Lambret, Lequeu and Robineau have drawn attention to the fact that, although the changes in blood and plasma chlorides after operation may not be very marked, there are definite changes in the distribution of chloride in the blood. Before operation, the value for the $\frac{\text{cell chloride}}{\text{plasma chloride}}$ ratio is about 0.5, but after operation the chloride shifts form the cells into the plasma so that the value for the ratio falls. Analysis of the results found for Case Nos. 50, 51 and 55 confirmed these findings as it was observed that the values for the ratio dropped from 0.49 to 0.27, 0.51 to 0.13, and 0.45 to 0.22 respective- -ly. The shift appeared to be a gradual process and to result mainly from changes in the relative distribution /

distribution of plasma to cells in the blood; a return of the packed cell volume reading to normal was accompanied by a similar improvement in the $\frac{\text{cell chloride}}{\text{plasma chloride}}$ ratio.

Sodium.

In 3 out of 4 cases, falls in the serum sodium concentration of an average of 17 mg.% were observed. The changes that occurred corresponded approximately to those found for plasma chlorides.

Potassium and Phosphorus.

Serial estimations for serum potassium and phosphorus were only made in one case. The potassium concentration dropped from 21.3 mg. to 17.2 mg. per 100 ml. serum by the 3rd day after operation and then returned to the pre-operative level. The inorganic phosphorus concentration fell from 3.5 to 2.0 mg. per 100 ml. serum on the day after operation and then gradually returned to a normal level.

DISCUSSION.

There can be little doubt that an enzymic hydrolysate of casein is an adequate source of protein food; the indications for its administration in preference to those of whole protein are, however, more difficult to find.

Co Tui et al. (1945) have claimed that protein hydrolysates have a specific action in the promotion of the healing of peptic ulcers. They considered that this was due mainly to the antacid properties of the protein hydrolysate. The secretagogue activity of protein hydrolysates has, however, been demonstrated and the antacid properties of the protein hydrolysate have been shown in vivo to be in no way superior to those of whole protein. The patients in the group described in this thesis were all well nourished, whereas Co Tui's patients were stated to be in a poor nutritional state. The giving of a high protein diet is known to promote wound healing (Clarke 1919) and it seems probable that the success of Co Tui's work, in contrast to that carried out in this hospital, may be attributed to the fact that the giving of massive doses of protein hydrolysate with adequate calories enabled the depleted protein reserves of his patients to be built /

built up more quickly than would have been possible on a milk diet. The total daily nitrogen intakes of the patients studied here were certainly not as great as those of Co Tui's patients, but owing to the un--paliatibility of the Pronutrin, the patients were unable to tolerate larger quantities; it is therefore possible that the differences in the two regimes may also have been responsible for the difference in the results obtained. The absorption of whole protein by peptic ulcer patients was not apparently impaired so that the giving of Pronutrin to such patients would only be justified if a sufficiently high protein intake could not be obtained using milk and dried milk powder. It is suggested that Co Tui's results were due to the administration of a diet with a very high nitrogen content to poorly nourished patients, and that the supplying of the nitrogen in the form of protein hydrolysate was merely incidental.

On theoretical grounds it seemed that oral protein hydrolysates, such as Pronutrin, would be of benefit to those whose ability to absorb whole protein was impaired, and accordingly two patients suffering from steatorrhoea were given 110 g. Pronutrin per day in addition to their ordinary diet. The proportion of dietary nitrogen which appeared in the faeces remained /

remained almost unaltered, so that it was evident that the Pronutrin had been of use only in providing a concentrated form of protein food which could be taken in addition to a normal diet. When given to two cases of anorexia nervosa there appeared to be no difference in the metabolism of Pronutrin and whole protein, so again no specific beneficial effect was observed.

Co Tui et al. (1944) also claimed to have used protein hydrolysates successfully in post-operative feeding after partial gastrectomy, and again using Pronutrin it was impossible to agree with their find--ings. The feeding of Pronutrin and glucose by intubation directly after operation stimulated gastric secretion to such an undesirable extent that its administration had to be stopped before any assessment of its nutritional value could be made. No difficulties in the absorption of the Pronutrin were encountered, but then neither were they in respect of whole protein when given in the form of a milk mixture. Using the milk mixture it was possible to give 90 g. protein and 1,800 calories per day, without most of the unpleasantness that accompanies the administration of Pronutrin and accordingly, this method of feeding was employed to study the effects of feeding on the protein /

protein catabolic phase. The quantities given were not sufficient to abolish the protein catabolic phase, but the cumulative nitrogen losses of the patients in this group were considerably less than those found with patients who were given only gradual feeding after operation.

Pronutrin was also given to four patients before operation in an endeavour to build up their protein reserves and thus to improve their ability to withstand the operation. High positive nitrogen balances indicated that the patients had absorbed the protein hydrolysate and utilised it for anabolism; the nitrogen losses after operation were not any greater than those found with the control group of patients so that it appeared as if the Pronutrin had been stored as tissue proteins, though weight changes were slight. No differences in clinical findings or weight losses were recorded as the result of this extra pre-operative feeding, so that for patients whose nutrition is good it did not seem to have any advantages.

It is impossible to begin normal feeding by mouth directly after the operation for partial gastrectomy, so that parenteral administration of protein hydrolysates would /

would appear to be of value in preventing at least some of the usual losses of nitrogen after operation. Whether the prevention of the "protein catabolic phase" after operation is desirable is a debatable point, but American workers including Co Tui (1944) and Riegal (1947) have been able to obtain positive nitrogen balances in the immediate post-operative period by the intravenous administration of considerable quantities of protein hydrolysate and glucose; intakes of more than 21 g. nitrogen together with 2,500 calories to 3,000 calories per day were, however, found to be necessary. The administration of the British preparation, Casydrol, to patients after operation did not, however, appear to benefit the patients clinically or to minimise the losses due to protein catabolism. This lack of success can be attributed in part to the fact that the amounts used were less than those used in the U.S.A. and also to the fact that of the 14 - 17g. nitrogen given each day less than 60% was actually metabolised, and of that which was metabolised, some would necessarily have been used for energy purposes on account of an inadequate caloric supply. The results from one experiment suggested that Amigen is better utilised by the human body after operation than Casydrol. Further confirmation is, however, necessary before concluding that the fault lay with the preparat-
-ion /

preparation of the protein hydrolysate, especially as the three medical cases appeared to be able to metabolise the Casydrol fairly efficiently; this may have been due to their being in a poor nutritional state (Silber 1946).

The quantities of nitrogen given in the milk mixture (average 14.4 g. nitrogen per day) were on the whole less than those given as Casydrol, but there is no doubt that the whole protein was better utilised than the protein hydrolysate. Other workers have also shown that intravenous feeding is inferior to oral feeding at the same level of nitrogen intake (Riegal 1945, Kozoll 1946, Varco 1947, and Mok 1948). What--ever the route of administration, amino acids are quickly removed from the circulation, so that it is difficult to explain the differences in the results beyond speculating that they are caused by the amino acids from the infusion fluid going into the general circulation and so not direct to the liver, while the amino acids from the food go into the portal circulat--ion. Excessive losses of nitrogen in the urine after operation have been shown to be accompanied by a fall in the amount of circulating plasma albumin. Weech (1938) has shown that the potency of various food stuffs for albumin regeneration varies, beef serum and egg white /

white being superior to beef muscle and casein. It is therefore possible that other protein hydrolysates could be used which might be better utilised than that of casein. Wienstein (1948) has reported on the safe intravenous administration of an enzymic digest of bovine blood; it contained 50% of its total nitrogen as amino acid nitrogen, none of which was apparently excreted in the urine. Krishman (1944), for the treat-ment of famine victims in India, used a papain digest of pork. Christensen (1947) has shown that the peptide portion of fibrin hydrolysates given intravenously is better utilised than that of casein hydrolysates. Kozoll (1946) has incorporated an odourless and tasteless partial alkaline degradation product of lactalbumin as a suspension in solid or liquid food in order to give high protein diets after operation; using this product (Essenamine), he has been able to obtain positive nitrogen balances of 1 - 20 g. nitrogen soon after operation without any of the disturbing side effects associated with intubation feeding or intravenous administration of casein protein hydrolysates. The use of mixtures of synthetic amino acids has also been attempted (Werner 1947), and again if sufficient quantities are given it has been found possible to obtain positive nitrogen balances immediately after gastric /

gastric operations. One of the main difficulties incurred in the parenteral administration of protein hydrolysates has been to give sufficient calories, and in an attempt to overcome this difficulty a homogeneous emulsion has been prepared from gelatine, amino acid solution, glucose and edible coconut oil which has been given as an intravenous infusion to animals and two medical cases (Shafiroff and Frank 1947). No known reports of its use in surgical patients have yet been made, but it may well prove to be of considerable value if the preparation can be perfected to avoid reactions.

Nitrogen losses after operation could not be correlated with the very variable weight losses on account of accompanying changes in fluid balance. In agreement with other workers (Howard and Mason 1946, Browne 1945) it was found that these losses were less in the debilitated patients. Cuthbertson and Munro (1943) have suggested that some of the nitrogen losses after operation result from storage protein, possibly as labile liver cytoplasm (Kosterlitz 1944), so that a small loss indicates a lack of storage proteins.

Whichever method of feeding after operation is employed, it is obvious that, in order to obtain nitrogen equilibrium, considerably larger quantities of protein are /

are required than are normally necessary. Assuming the truth of the concept of the "dynamic state of body structure" proposed by Schoenheimer (1942), it appears that after operation the rate of protein catabolism is increased, while the rate of protein anabolism remains normal; thus, applying the Law of Mass Action, for an instance of tissue, equilibrium will only be obtained if the mass of amino acids available for protein synthesis is increased.

Cuthbertson (1945) has suggested that the occurrence of the protein catabolic phase was due to the raiding of the body for a supply of amino acids necessary for reparative processes, and for mobilisation of oxidisable material to enhance metabolism of healing processes. It is possible, therefore, that there is an increased demand for particular amino acids, but attempts to ascertain this have so far been unsuccessful. Croft and Peters (1945) have described experiments in which the nitrogen losses of rats with burns were reduced by the administration of methionine, but this nitrogen sparing effect of methionine has not been confirmed in humans (Allison 1947), and lately Sellers and Best (1949) have found that its effect is not significant in adult rats.

After /

After operation it has been shown that, whereas the excretion of 17 keto-steroids is only increased within the first 24 - 48 hours (Forbes 1947), the excretion of cortico-steroids in the urine is increased for a considerably longer period (Talbot 1947). This production of cortico-steroids has been considered to be an essential part of the body's defensive mechanism to trauma (Selye 1946) and its increased excretion appears to indicate hyper-activity of the adrenal cortex. Corticosterone is probably identical with the "S" hormone and if so is concerned with increased protein catabolism. The similarity between adrenal insufficiency and traumatic shock have been discussed by Clarke and Cleghorn (1942), while Larget and Lamare (1941) have considered adrenal insufficiency to be a probable cause of the "Maladie Post-Operatoire". The changes of blood chemistry found after operation in this study were almost identical with those described in this syndrome, which suggests that either the causal factors are probably the same, or that the blood changes are the result of adrenal cortical hyper-activity.

The periods of increased cortico-steroid excretion and increased nitrogen excretion do not always occur at exactly the same time (Venning 1944), and whereas in-
-jections of pituitary corticotrophic hormone stimulate urinary /

urinary cortico-steroid excretion, they have no effect on the urinary nitrogen excretion (Schenker and Stevenson 1943). Increased adrenal activity is, therefore, only one of several factors involved in protein catabolism. The adrenal cortex is also concerned with the control of salt and water metabolism, so that hyper-activity of the gland may be a possible reason for the inability of the patient to excrete sodium and chloride immediately after operation at approximately the same times as urinary nitrogen excretion is increased.

Borst (1949) has associated the reduction of urinary excretion of water and sodium chloride after operation with a reduction of cardiac output. He considers that retention of water and salt is not due to disturbances in the function of the kidney, but is an adaptation to the circulatory requirements by a hyper-function of the tubules. The retention of the saline is a defensive measure of the body against a reduced circulating blood volume so that only when the cardiac output is normal is the sodium chloride complete--ly excreted. No measurements of cardiac output were made on patients in this study, but it is perhaps relevant to note that in four patients, on whom salt balances were made, the days on which minimum albumin concentration, /

concentration, minimum packed cell volume and maximum chloride shift from cells to plasma were observed, were almost identical with the days on which salt retention ended. Improvements in the composition of the blood likely to result in an increased cardiac output were, therefore, associated with the termination of salt retention.

The importance of sodium as a constituent of the extracellular fluid is wellknown. Animal experiments have shown that after trauma there is an accumulation of extracellular fluid in the traumatised area, an exchange of sodium for the intracellular potassium and a loss of potassium from the injured tissue (Rosthenal and Tabor 1945, Ricca 1945, and Fox 1947). There is, therefore, an increased demand for sodium after trauma if the critical level of the volume of extracellular fluid is to be maintained. It is for this reason that McCarthey and Parkins (1947) have considered that the value of infusion fluids administered after trauma is related to their sodium content.

The development of an increased capillary permeability at the site of trauma has been considered to account for the decrease of circulating albumin (Howland and Mahoney 1948), and it may be concerned with the /

the increase of salt and water in the tissues. The giving of saline infusions after operation may help to maintain the volume of extracellular fluid at a normal level, but at the same time it may also increase the amount of salt and water accumulating in the traumatised tissue. The problem that arises is how best to balance the extracellular fluid requirements with the prevention of excess saline in the traumatised tissue.

The complexity of the changes in salt metabolism which result from operation is obvious. It is, there--fore, not surprising that no simple chemical estimation is of use in indicating the salt requirements of the patient at this time. The chloride concentration of the blood may give an erroneous impression, since salt retention has been observed with both raised and depressed values. Lack of salt in the urine is likewise no indication that the patient has not been given an adequate salt intake, since, for a variety of reasons, the patient is unable to excrete salt in the immediate post-operative period. A further knowledge of the problems involved is, therefore, required before a simple procedure can be found which will give the clinician a clear idea of his patients' salt requirements.

REFERENCES.

ABBOT, W.E. (1946) Surg. 20, 284 and 770.

ABDERHALDEN, E. and RONA, P. (1904) Z. Phys. Chem., 42, 525

ALBANESE, A.A. and IRBY, V. (1944) J. Biol. Chem., 153, 583.

ALBRIGHT, F. (1947) Personal communication to R. Elman, quoted Parenteral Aliment--ation - Hamish Hamilton Medical Books.

ALLISON, J.B., ANDERSON, J.A. and SEELEY, R.D. (1947) Nutrition, 33, 361.

BARTLETT, R.M., BINGHAM, D.L. and PEDERSON, S. (1938) Surgery 4, 41 and 614.

BEATTIE, J. (1947) Brit. Med. J. 813.

BENEDICT, F.G. (1915) A Study of Prolonged Fasting, Washington.

BENEDICT, S.R. (1909) J. Biol. Chem. 6, 363.

- and FRANKE, E. (1922) J. Biol. Chem., 52, 387.

BIDDER, F. and SCHMIDT, C. (1852) Die Verdauungssafte und der Stuffwechsel. Leipzig. p. 333.

BIGHAM, R., MASON, E. and HOWARD, J.E. (1947) Southern Med. J. 40, 238.

BORST, J.G.G. (1949) Acta Medica Scandinavica 130. Supplementum 207.

BOWLER, R.G. (1944) Biochem. J. 38, 385.

BROWNE, J.S.L., SCHENKER, V. and STEVENSON, J.A.F. (1944) J.Clin. Invest. 23,932.

- - VENNING, E.H. and JOHNSON, L.G. (1946) Conference on Bone and Wound Healing, Josiah Macy, jr. Foundation XIV.

- - - (1946) Conference on Bone and Wound Healing, Josiah Macy, jr. Foundation XIII.

BRUNSCHWIG /

BRUNSCHWIG, A., CLARK, D.E. and CORBIN, N. (1942) Ann. Surg. 115, 1091.

- BIGELOW, R and NICHOLS, S. (1945) J.A.M.A. 129, 441.

BUTLER, A.M. and TUTHILL, E. (1931) J. Biol. Chem., 93, 171.

CANNON, P.R., WISSLER, R.W., WOODRIDGE, R.L. and BENDITT E.P. (1944) Ann. Surg. 120,524.

CASTEN, D., BODENHEIMER M. and BARCHAM, I. (1943 Ann. Surg. 117, 52.

CAMPBELL, K., IOB, V. and BERRY, R. (1946) Surgery 20, 310.

CHIBNELL, A.C., REES, M.W., and WILLIAMS, E.F. (1943) Biochem. J. 37, 354.

CHINARD, F.P. and VAN SLYKE, D.D. (1947) J. Biol. Chem. 169. 57.

CHITTENDEN, R.H. (1905) Physiological Economy in Nutrition. F.A.Stokes Co. New York.

CHRISTENSEN, H.N., LYNCH, E.L. and POWERS, J.M. (1946) J. Biol. Chem. 166, 649.

- - DECKER, D.G. and POWERS, J.M. (1947) J. Clin. Invest. 26, 849 and 853.

CLARKE, A.P.W. and CLEGHORN, P. (1942) Endocrinology 31, 597.

CLARKE, A.H. (1919) Bull. John. Hopkins Hosp. 30,117.

COLE, W.H. (1947) Ann. Surg. 126, 592.

COLLER, F.A. and MADDOCK W.G. (1940) Surg. Gyn. and Obst. 70, 340.

- CAMPBELL, K.N., VAUGHAN, H.H., IOB, V. AND MOYER, C.A. (1944) Ann.Surg. 119, 533.

COLLER, F.A., IOB, V., VAUGHAN, H.H., KALDER, N.B., AND MOYER, C.A. (1945) Ann. Surg. 122, 663.

CO TUI /

CO TUI, WRIGHT, A.M. and MULHOLLAND, J.H. et al.(1944) Ann.Surg.120,99.

- - - - (1945) Gastroenterology, 5,517.

COX, W.M. and MUELLER A.J. (1939) Proc. Soc. Expt. Biol. and Med.42, 658

- - (1946) J. Nutrition. 131, 581.

CRICHTON-BROWNE (1909) Delusions in Diet. Funk and Wagnells Co. New York.

CUTHBERTSON, D.P. (1929) Biochem. J. 23, 1328.

- - (1930) ibid 24, 1244.

- - (1931) ibid 25, 236

- - (1932) Quart. J. Med. 25, 233.

- - (1936) Brit. J. of Surg. 23, 505.

- McGIRR, J.L. and MUNRO, H.N. (1939) J. Exp. Phys. 29, 13.

- MUNRO, H.N. (1939) Biochem. J. 33, 128.

- (1940) Nut. Abstracts and Review 10, 1.

- (1942) Lancet 433.

- (1944) Brit. Med. Bull. 2.

- (1945) Lancet, 786.

- (1948) Brit. Med. J. 731.

DARROW, D.C. (1945) New Eng. J. Med. 23, 39.

DISCOMBE, G. (1943) St. Bartholomew's Hosp.J. 47,238.

ECKHARDT, R.D., LEWIS, J.H., et. al. (1948) J.Clin. Inv. 27, 119.

ELMAN, R. (1937) Proc. Soc. Exp. Biol. and Med. 36, 867.

- (1938) ibid 37, 610.

- and WEINER, D.O. (1939) J.A.M.A. 112, 796.

- /

ELMAN, R (1940) Ann. Surg. 112, 594,

- and LISCHER, C.E. (1943) Ann. Surg. 118, 225.

- SACHAR, L.A., HORWITZ, A. AND WOLFF, H. (1943) Arch. Surg. 47, 216,

- (1944) Ann. Surg. 120, 350.

- (1949) Brit. Med. J. 150.

- DAVEY, H.W., and KYASAU (1945) J. Lab. Clin. Med. 30, 273.

FOLIN, O. (1914) J. Biol. Chem. 17, 469.

- and WU, H. (1919) ibid 38, 81.

- (1930) ibid 86, 179.

FOX, C.L. AND BAER, H. (1947) Amer. J. Physiol. 151, 155.

FORBES, A.P. and DONALDSON,E.C. et al. (1947) J. Clin. Endocrinology 7, 264.

FRAME,E.G., RUSSEL, J.A. and WILHELMI, A.E. (1943) J. Biol. Chem. 149, 1255. 255

- - - (1944) ibid 156, 467. Not Fra Russel/J.

FRIEDRICH, P.L. (1904) Arch. f. klin. Chir. 73,507.

GEIGER, E. (1948) J. Nutrition 36, 813.

GIBSON, J.L. and EVANS, W.A. (1937) J. Clin. Invest. 16, 317.

GROSSMAN, G.M., SAPPINGTON, T.S., BURROWS, B.A. et al. (1945) J. Clin. Invest. 24, 523.

GRAHAM, G. AND POULTON, E.P. (1912-13) Quart. J. Med. 6, 82.

HENRY, K.M. AND KON, S.K. (1946) J. Dairy Research, 14, 330.

HENRIQUES,V. AND ANDERSON, A.C. (1913) Z. Physiol. Chem. 88, 357.

HIMSWORTH /

HIMSWORTH, H.P. (1946) Proc. Roy. Soc. Med. 40, 27.

HODDER, E.M. (1873) Practitioner 10, 14.

HOPKINS, F.G. and WILLOCK, E.G. (1906) J. Phys. 35, 88.

- (1916) J. Chem. Soc. 109, 629.

HOWARD, J.E., PARSON, W., EISENBERGSTEIN, K. et al. (1944) Bull. John Hopkin. Hosp. 75, 156.

- - - - (1944) ibid 75, 209.

- (1945) Arch. Surg. 50, 166.

- BIGHAM, R.S. EISENBERG, W. et al. (1946) Bull. John Hopkin. Hosp. 178, 282.

- and MASON, R.E. (1946) Conference on Bone and Wound Healing, Josiah Macy jr. Foundation XIII.

HOWLAND, J.W. and MAHONEY, E.B. (1943) Surg. 13, 889.

IOB, V., BERRY R.E.L. and CAMPBELL, K.C.N. (1949) Abstracts. World Surg. Obstet. and Gynae. 5, 6.

KENNAMORE, B., LANERGAN, W. and SHY, J.C. (1948) Gastroenterology, 10, 177.

KEYS, A., TAYLOR, H.L. et al. (1946) Science, 103, 669.

KOSTELITZ, H.W. (1944) Nature, 154, 207.

KOZOLL, D., HOFFMAN, W.S. and MEYER, K.A. (1945) Arch. Surg. 51, 59.

- (1946) Arch. Surg. 53, 683.

KRISHMAN, K.V., NARAYANAN, E.R. and KARAN, J. (1944) Ind. Med. Gazette 79, 160.

LABBY, D.H. AND HOAGLAND, C.L. (1947) J. Clin. Invest. 26, 343.

LAMBRET, M.O. (1933) Bull et Mem. de la Soc. Nat. de Chir. 59, 1416.

- and DRIESENS, J. (1937) J. Internat. de Chir. 2, 223.

LARGET, M. AND LAMARE, J.P. (1941) La Presse Medicele 49, 116.

LARSON /

LARSON, P.S. AND CHAIKOFF, P.I.L. (1937) J. Nutrition 13, 287.

LEGUEU, F., FEY, B., PALAZZOLI and LEBERT (1933 Bull. acad. de med. Paris, 109, 879.

LIEBIG, J. (1842) Die organische Chemie in ihrer Anwendung auf Physiologie und Pathologie. Brauschweig.

LOEWI, O. (1902) Arch. exper. Path. u. Pharm. 48, 303.

LUSK, G. (1928) The Elements of the Science of Nutrition, London, W.B. Saunders, 4th ed.

MADDEN, S.C., ZEILDIS, L.J. et al. (1941) J. Exp. Med. 73, 727.

- WOODS, R.R. , SHULL, F.W. and WHIPPLE, G.H. (1944) J. Exp. Med. 79, 607.

- AND WHIPPLE, G.H. (1944) Medicine, 23, 215.

MARRIOT, H.L. (1947) Brit. med. J. 247, 285, 328.

MATAS, R. (1924) Ann. Surg. 79, 643.

MAYOCK, R.L., KOOP, C.E. RIEGAL, C. et al. (1946) Am. J. Med. Soc. 212, 591.

McCANCE, R.A. and WIDDOWSON, E.M. (1946) The Chemical Composition of Foods, Med. Res. Counc. Spec. Rep. Series, No. 235, 2nd ed.

McCARTHEY, M.D. and PARKINS, W.M. (1947) Am.J. Phys. 150, 436.

McCAY (1912) The Protein Element in Nutrition. Edward Arnold, London.

MEYER, F.L. HIRSCHFELD, J.W., ABBOT, W.E. et al. (1947) Am. J. Med. Sc. 213, 160.

MOK, W.T., KOZOLL, D.D. and MEYER, K.A. (1948) Surg. 24, 954.

MULHOLLAND, J.H. CO TUI, WRIGHT A.M. AND VINCI, V.J. (1943) Ann. Surg. 117, 512.

MUNRO, H.N. and CHALMERS, M.I. (1945) Brit. J. Exp. Path. 26, 396.

NORTHROP /

NORTHROP, J.H. (1926) J. Gen. Phys. 9, 759

NATIONAL RESEARCH COUNCIL, U.S.A. FOOD AND NUTRITION BOARD (1943)

OSBORNE, T.B. and MENDEL, L.B. (1911) Pub. Carnegie Inst. of Washington, No.156, pts. I and II.

PETERS, J.P. (1944) Federation Proc. 3, 197.

- and VAN SLYKE, D.D. (1932) Quantitave Clinical Chemistry VolII pp. 379, 599, 736, 741.

POPJAK, G. and McCARTHEY, E.F. (1946) Biochem. J. 40, 789.

REIFENSTEIN, E.C. (1945) Conference on Bone and Wound Healing, Josiah Macy jr. Foundation IX.

RICCA, R.A., FINK, K., STEEDMAN, L.T. and WARREN, S.L. (1947) J. Clin. Invest. 24, 140.

RIEGAL, C. RHOADS, J.E., KOOP, C.E. et al. (1945) J.A.M.Sc. Proc. 210, 133.

- KOOP, C.E. et al. (1947) J. Clin. Invest. 26, 18.

ROBINEAU, M. (1933) Bull. et Mem. Soc. Nat. de Chir. 59, 519.

ROBINSON, J.R. (1948) Am. J. Surg. 76, 383.

ROSENTHAL, S.M. and TABOR, H. (1945) Arch. Surg. 51, 244.

ROSS, C.A. and ELMAN, R. (1948) Science 108, 441.

ROSSIEN, A.X. (1947) Am. J. Dig. Dis. 14, 205.

RUBNER, M. (1903) Handbuch der Ernahrungstherapie. (E. van Leyden) p. 43.

SCHOENHEIMER, R. (1942) The Dynamic State of Body Constituents. Harvard Univ. Press. Camb. Mass.

SELLERS, E.A. and BEST, C.H. (1949) Brit. Med. J. 522.

SCHAFFER, /

SCHAFFER, P.A. and COLEMAN, W. (1909) Arch. Int. Med. Chicago. iv.538.

SCHENKER, V. and STEVENSON, J.A.P. (1943) Conference on Bone and Wound Healing, Josiah Macy jr. Foundation IV, 91.

SCHMID, E. (1933) Mitt. Geb. Lebensmittel Hyg. 24, 195.

SELYE, H. (1946) J. Clin. Endocrinology 6, 117.

SHAPIROFF, B.F. and FRANK, C. (1947) Science, 106, 475.

SHERMAN, H.C. (1935) Chemistry of Food and Nutrition. McMillan, New York.

STEWART, J.D. and ROURKE, G.M. (1938) J. Clin. Invest. 17, 413.

- - (1942) ibid 21, 197.

- HALE, H.W. and SCHAER, S.M. (1948) J.A.M.A. 136, 1017.

SHOHL, A.T. BUTLER, A.M. et al. (1939) J. Pediat. 15, 469.

SMYTHE, C.J., LEVEY, S. and LASICHAK, A.G. (1948) J. Clin. Invest. 27, 413.

STOHL, A.T. and BENNET, H.B. (1928) J. Biol. Chem. 78, 643.

TALBOT, N.B., ALBRIGHT, F., SALTZMAN, A.H. et al. (1947) J. Clin. End. 7,331.

TERROINE, E.F. (1936) Quart. Bull. Health Org. of League of Nations, 5, 855.

THERON, P.H. and WILSON, W.C. (1949) Lancet, 256, 172.

VAN SLYKE, D.D. and CULLEN, G.E. (1917) J. Biol. Chem. 30, 289.

- and SENDROY, J. (1923) J. Biol.Chem. 58, 523.

VAN SLYKE /

VAN SLYKE, D.D. (1929) J. Biol. Chem. 83, 449.

- and KIRK, E. (1933) J. Biol. Chem. 102, 651.

- McFAYDEN, D.A. and HAMILTON, P. (1943) J. Biol. Chem. 150, 251.

VARCO, R.L. (1947) Surg. Gynec. Obstet. 84, 611.

VENNING, E.H. (1944) Conference on Bone and Wound Healing. Josiah Macy jr. Foundation VII, 117.

VOIT, C. (1866) Z.f. Biol. 2, 235.

WEECH, A.A. (1938) Harvey Lectures.

WEINSTEIN, J.J. (1948) Surg. Gynec. and Obstet. 87, 93.

de WESSELOW, O.L.V. (1924) Int. Clin. 3, 191.

WERNER, S.C. (1947) Ann. Surg. 126, 169.

WERNHEIMER, (1919) quoted. D.P. Cuthbertson (1942) Lancet 433.

WILKINSON, A.W., BILLING, B.H., NAGY, G. and STEWART, C.P. (1949) Lancet, 256, 640.

WOODYATT, R.T. SANSUM, W.D. and WILDER, R.M. (1915) J.A.M.A. 65, 2067.

ZELLER, H. (1914) Arch. F. Physiol. 213.

APPENDIX.

1. Nitrogen and Salt Balances.
2. Blood Chemistry.

ABBREVIATIONS.

T.P.	=	Total Plasma Protein, g/100 ml.plasma.
Alb.	=	Albumin, g/100 ml. plasma.
Glob.	=	Globulin, g/100 ml. plasma.
N.P.N.	=	Non Protein Nitrogen, g/100 ml. plasma.
B.U.N.	=	Blood Urea Nitrogen, mg./100 ml. blood.
P.U.N.	=	Plasma Urea Nitrogen, mg./100 ml. plasma.
B.A.N.	=	Blood Amino Acid Nitrogen, mg./100 ml. blood.
P.A.N.	=	Plasma Amino Acid Nitrogen, mg./100 ml. plasma.
Creat.	=	Creatinine, mg./100 ml. blood.
U.A.	=	Uric Acid, mg./100 ml. blood.
Bl.Cl.	=	Blood Chloride (as NaCl), mg./100 ml. blood.
P.Cl.	=	Plasma Chloride (as NaCl), mg./100 ml. plasma.
Na.	=	Sodium, mg./100 ml. serum.
K.	=	Potassium, mg./100 ml. serum.
P.	=	Phosphorus, mg./100 ml. serum.
CO_2CP	=	Carbon Dioxide Combining Power, vols.%.
Hb.	=	Haemoglobin.
R.B.C.	=	Red Blood Cells/c.mm., in millions.
P.C.V.	=	Packed Cell Volume.

All figures in the nitrogen and chloride balance charts refer to gramms unless otherwise stated.

Temperatures above 98.4°F. have been recorded.

Height 5 ft. 5 ins.

CASE No.1.

DATE		PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE −	WEIGHT IN LB.
June	24	56	125	70	240	2314	23.96	1865	14.02	3.72	17.74	5.22		128.25
	25	56	125	70	240	2314	23.96	2060	17.80	1.41	19.21	4.75		
	26	56	125	70	240	2314	23.96	2295	17.83	2.45	20.28	3.68		
	27	56	125	70	240	2314	23.96	1610	16.18	nil	16.18	7.78		
	28	56	125	70	240	2314	23.96	1890	combined		21.25	2.71		
	29	56	125	70	240	2314	23.96	2050	17.10	nil	17.10	6.86		
	30	56	125	70	240	2314	23.96	2010	combined		25.80		1.84	
July	1	56	125	70	240	2314	23.96	2090	15.95	1.14	17.09	6.87		129.75
	2	56	125	70	240	2314	23.96	1910	18.30	nil	18.30	5.66		
	3	56	125	70	240	2314	23.96	2270	19.97	0.57	20.54	3.42		
	4	56	125	70	240	2314	23.96	2650	24.90	0.72	25.62		1.66	
	5	56	125	70	240	2314	23.96	1500	13.74	3.08	16.82	7.14		
	6	56	125	70	240	2314	23.96	2200	21.00	nil	21.00	2.96		
	7	56	125	70	240	2314	23.96	2320	21.60	4.48	26.08	2.14		
	8	56	125	70	240	2314	23.96	2120	19.10	0.99	20.09	3.87		129.65
	9	56	125	70	240	2314	23.96	2310	16.60	4.22	20.82	3.14		
	10	56	125	70	240	2314	23.96	3240	22.20	nil	22.20	1.76		
	11	56	125	70	240	2314	23.96	1860	18.80	0.42	19.22	4.74		
	12	56	125	70	240	2314	23.96	2200	19.45	nil	19.45	4.51		
	13	56	125	70	240	2314	23.96	2530	18.20	3.66	21.86	2.10		
	14	56	125	70	240	2314	23.96	2300	20.10	3.08	23.18	.18		129.65

Height 5 ft. 3 ins.

CASE No. 2.

DATE	PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
Aug. 30	65	110	87	314	2739	23.60	2240	17.70	nil	17.70	5.90		117.5
31	65	110	87	314	2739	23.60	2480	16.35	1.12	17.47	6.13		
Sept. 1	65	110	87	314	2739	23.60	1560	10.40	3.14	13.54	10.06		
2	65	110	87	314	2739	23.60	2720	22.25	nil	22.25	1.35		118.5
3	65	110	87	314	2739	23.60	1780	16.02	1.90	17.92	5.68		
4	65	110	87	314	2739	23.60	2550	21.80	nil	21.80	1.80		
5	65	110	87	314	2739	23.60	2310	19.50	2.08	21.58	2.02		
6	65	110	87	314	2739	23.60	2590	15.00	0.22	15.22	8.38		
7	65	110	87	314	2739	23.60	1790	17.10	1.92	19.02	4.58		
8	65	110	87	314	2739	23.60	2440	21.45	1.17	22.62	0.98		
9	65	110	87	314	2739	23.60	1480	8.75	1.26	10.01	13.59		117.5
10	65	110	87	314	2739	23.60	1710	16.96	3.58	20.54	3.06		
11	65	110	87	314	2739	23.60	2490	24.70	nil	24.70		1.10	
12	65	110	87	314	2739	23.60	2370	15.20	nil	15.20	8.40		
13	65	110	87	314	2739	23.60	2200	19.10	1.10	20.20	3.40		
14	65	110	87	314	2739	23.60	2200	22.20	1.22	23.42	0.18		
15	65	110	87	314	2739	23.60	2520	19.60	1.93	21.53	2.07		118

Height 6 ft.

CASE No. 3.

DATE	PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
Aug. 27	65	110	87	314	2739	23.60	960	15.90	1.40	17.30	6.30		125.25
28	65	110	87	314	2739	23.60	1280	20.90	5.60	26.50		2.90	
29	65	110	87	314	2739	23.60	2040	24.20	nil	24.20		0.60	
30	65	110	87	314	2739	23.60	1400	21.80	nil	21.80	1.80		
31	65	110	87	314	2739	23.60	2240	26.80	3.18	29.98		6.42	
Sept. 1	65	110	87	314	2739	23.60	890	13.20	nil	13.20	10.40		
2	65	110	87	314	2739	23.60	1420	17.75	nil	17.75	5.80		126.5
3	65	110	87	314	2739	23.60	1590	17.75	2.92	20.67	2.93		
4	65	110	87	314	2739	23.60	1490	20.20	nil	20.20	3.40		
5	65	110	87	314	2739	23.60	1610	18.80	1.46	20.26	3.34		
6	65	110	87	314	2739	23.60	1780	20.70	nil	20.70	2.90		
7	65	110	87	314	2739	23.60	1350	20.30	nil	20.30	3.30		
8	65	110	87	314	2739	23.60	1870	23.80	3.18	26.98		3.38	128
9	65	110	87	314	2739	23.60	1240	15.55	nil	15.55	8.05		
10	65	110	87	314	2739	23.60	1300	21.50	1.10	22.60	1.00		
11	65	110	87	314	2739	23.60	1700	22.20	1.26	23.46	0.14		
12	65	110	87	314	2739	23.60	1400	21.80	1.16	22.96	0.64		
13	65	110	87	314	2739	23.60	1280	19.15	nil	19.15	4.45		
14	65	110	87	314	2739	23.60	1400	20.10	nil	20.10	3.50		
15	65	110	87	314	2739	23.60	1670	19.80	nil	19.80	3.80		128

CASE No. 4 Height: 5 ft. 7 ins.

		INTAKE						OUTPUT				N BALANCE		
DATE		PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL EXCRETION	+	-	WEIGHT in LBS.
Aug.	4	57	120	67	235	2251	23.52	1950	26.60	.33	26.93		3.38	125.8
	5	57	120	67	235	2251	23.52	1550	17.20	nil	17.20	6.32		
	6	57	120	67	235	2251	23.52	880	15.84	3.42	19.26	4.26		
	7	57	120	67	235	2251	23.52	1320	12.60	nil	12.60	10.92		126.7
	8	57	120	67	235	2251	23.52	1710	23.80	2.62	26.42		2.90	
	9	57	120	67	235	2251	23.52	1330	25.80	1.05	26.85		3.33	
	10	57	120	67	235	2251	23.52	1600	14.90	nil	14.90	8.62		
	11	57	120	67	235	2251	23.52	2230	23.40	nil	23.40	.12		
	12	57	120	67	235	2251	23.52	1610	23.70	2.86	26.56		3.04	124
	13	57	120	67	235	2251	23.52	2450	17.50	nil	17.50	6.02		
	14	57	120	67	235	2251	23.52	1610	14.90	3.12	18.02	5.50		
	15	57	120	67	235	2251	23.52	2320	25.00	nil	25.00		1.48	
	16	57	120	67	235	2251	23.52	2215	21.50	3.00	24.50		0.98	
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CASE No. 4 (Contd.)

DATE	PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL EXCRETION	N BALANCE +	N BALANCE -	WEIGHT in LBS.
	INTAKE						OUTPUT						
Aug. 17	102	120	121	330	3297	30.72	2030	21.80	3.04	24.84	5.88		
18	102	120	121	330	3297	30.72	1900	28.80	1.12	29.92	0.80		
19	102	120	121	330	3297	30.72	2060	24.00	3.16	27.16	3.56		125.3
20	102	120	121	330	3297	30.72	2460	28.00	1.60	29.60	1.12		
21	102	120	121	330	3297	30.72	2550	24.00	2.80	26.80	3.92		
Sept. 8	65	110	87	314	2739	23.60	2410	15.20	1.42	16.62	6.98		
9	65	110	87	314	2739	23.60	2660	17.60	0.58	18.18	5.42		128.5
10	65	110	87	314	2739	23.60	2370	16.50	nil	16.50	7.10		
11	65	110	87	314	2739	23.60	2380	19.40	nil	19.40	4.20		
12	65	110	87	314	2739	23.60	2630	18.10	1.15	19.25	4.35		
13	65	Casein 110	87	314	2739	23.60	2760	19.65	nil	19.65	3.95		
14	65	110	87	314	2739	23.60	2060	17.80	5.48	23.28	0.32		
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CASE No. 4 (Contd.)

	INTAKE						OUTPUT				N BALANCE		
DATE	PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL EXCRETION	+	-	WEIGHT in LBS.
Sept. 15	65	110	87	314	2739	23.60	2390	17.60	nil	17.60	6.00		
16	65	110	87	314	2739	23.60	2400	16.25	2.24	18.49	5.11		128
17	65	110	87	314	2739	23.60	2080	20.15	nil	20.15	3.45		
18	65	110	87	314	2739	23.60	2380	20.60	2.86	23.46	0.14		
19	65	110	87	314	2739	23.60	2150	19.30	nil	19.30	4.30		
20	65	110	87	314	2739	23.60	2560	19.30	nil	19.30	4.30		
21	65	110	87	314	2739	23.60	1430	19.10	3.80	22.90	0.70		
22	65	Pronutrin 110	87	314	2739	23.60	1650	28.20	nil	28.20		4.60	
23	65	110	87	314	2739	23.60	1840	21.80	3.12	24.92		1.30	128
24	65	110	87	314	2739	23.60	1900	19.80	nil	19.80	3.80		
25	65	110	87	314	2739	23.60	1750	19.80	3.46	23.26	0.34		
26	65	110	87	314	2739	23.60	1840	16.70	1.08	17.78	5.82		
27	65	110	87	314	2739	23.60	2000	22.40	0.92	23.32	0.28		
28	65	110	87	314	2739	23.60	1460	14.68	3.88	18.56	5.04		
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CASE No. 4 (Contd.)

			INTAKE						OUTPUT				N BALANCE		
DATE		PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL EXCRETION	+	-	WEIGHT in LBS.
Sept.	29	65	110	87	314	2739	23.60	1350	15.70	nil	15.70	7.90		
	30	65	110	87	314	2739	23.60	1680	17.00	1.82	18.82	4.78		128.2
Oct.	1	65	110	87	314	2739	23.60	2650	18.55	nil	18.55	5.05		0
	2	65	110	87	314	2739	23.60	1860	18.60	3.36	21.96	2.04		
	3	65	110	87	314	2739	23.60	1650	13.05	2.60	15.65	7.95		
	4	65	110	87	314	2739	23.60	1450	15.65	0.42	16.07	7.53		
	5	65	110	87	314	2739	23.60	2500	21.48	nil	21.48	2.12		
	6	92	110	117	393	3442	27.92	2256	20.3	2.32	22.62	5.28		
	7	92	110	117	383	3402	27.92	1630	22.40	0.24	22.64	5.26		
	8	92	110	117	383	3402	27.92	2660	23.18	1.33	24.51	3.39		
	9	92	110	117	383	3402	27.92	2400	20.55	nil	20.55	7.35		130

Height 5 ft. 6 ins.

CASE No. 5.

DATE		PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
Oct.	28	66	160	70	337	2882	29.76	1520	19.15	0.78	19.93	9.83		133
	29	66	160	70	337	2882	29.76	1080	18.87	1.60	20.47	9.29		
	30	66	160	70	337	2882	29.76	1865	31.20	0.94	32.14		2.38	
	31	66	160	70	337	2882	29.76	1745	35.20	1.83	37.03		7.27	
Nov.	1	66	160	70	337	2882	29.76	1740	28.90	1.06	29.96		0.20	
	2	66	240	70	337	3202	39.36	1510	16.80	2.36	19.16	20.20		
	3	66	240	70	337	3202	39.36	1990	40.80	2.78	43.58		4.22	
	4	48	180	45	149	1813	29.28	1310	28.60	1.70	30.10		0.82	135
	5	66	240	70	337	3202	39.36	1560	34.10	0.34	34.44	4.92		
	6	66	240	70	337	3202	39.36	1810	39.20	nil	39.20	0.16		
	7	66	240	70	337	3184	39.36	1810	38.50	1.80	40.30		0.94	
	8	66	240	68	337	3202	39.36	1720	35.00	2.22	37.22	2.14		
	9	66	240	70	337	3202	39.36	2070	39.50	2.00	41.50		2.14	
	10	66	240	70	337	3202	39.36	1900	36.41	nil	36.41	2.95		
	11	66	240	70	337	3202	39.36	2180	41.60	nil	41.60		2.24	137
	12	66	240	70	337	3202	39.36	1900	40.20	1.10	41.30		1.94	
	13	66	90	70	337	2602	21.36	2610	37.88	2.56	40.44		19.04	
	14	66	-	70	337	2242	10.56	1260	15.50	1.22	16.72		6.16	136

CASE No. 6

DATE		PROTEIN	PRONUTRIN	N INTAKE	URINE N	STOOL N	N LOSS	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
April	26	21	80	12.96	16.25	.8	17.05		4.09	121.8
	27	21	80	12.96	11.30	1.5	12.80	0.16		
	28	21	80	12.96	16.00	1.55	16.55		3.59	
	29	21	80	12.96	14.50	0.8	15.38		2.42	121.8
	30	21	80	12.96	15.5	nil	15.50		2.54	
May	1	21	80	12.96	14.60	1.4	16.00		3.04	
	2	21	80	12.96	11.20	1.3	12.50	0.46		
	3	21	80	12.96	12.2	0.9	13.10		0.14	
	4	21	80	12.96	12.0	0.4	12.40	0.56		
	5	21	80	12.96	13.30	1.2	14.50		1.54	
	6	21	80	12.96	13.50	0.7	14.20		1.24	119.8
	7	21	80	12.96	15.60	1.2	16.80		3.84	
	8	21	80	12.96	11.30	1.4	12.70	0.26		
	9	21	80	12.96	11.20	1.2	12.40	0.56		
	10	70	125	26.20	13.0	0.4	13.40	12.80		
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CASE No. 6 (Contd.)

DATE		PROTEIN	PRONUTRIN	N INTAKE	URINE N	STOOL N	N LOSS	N BALANCE +	N BALANCE −	WEIGHT IN LBS.
May	11	70	125	26.20	12.40	2.3	14.70	11.50		
	12	70	125	26.20	17.0	1.0	18.00	8.30		
	13	70	125	26.20	17.50	1.7	18.20	8.00		120.2
	14	70	125	26.20	22.0	1.8	23.80	2.40		
	15	70	125	26.20	21.6	1.4	23.00	3.20		
	16	70	125	26.20	23.5	1.0	24.5	1.70		
	17	70	125	26.20	17.8	3.0	20.8	5.40		
	18	70	125	26.20	22.4	1.4	23.8	2.40		
	19	70	125	26.20	21.0	0.5	21.5	4.70		
	20	70	125	26.20	16.75	3.0	19.75	6.45		
	21	70	125	26.20	14.80	nil	14.80	11.40		
	22	70	125	26.20	25.60	0.7	26.30		0.10	
	23	70	125	26.20	21.20	2.5	23.7	2.50		
	24	70	125	26.20	20.3	1.4	21.7	4.50		
	25	70	125	26.20	24.0	1.6	25.6	0.60		
	26	70	125	26.20	13.2	0.7	13.9	12.30		

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CASE No. 6 (Contd.)

DATE		PROTEIN	PROMUTRIN	N INTAKE	URINE N	STOOL N	N LOSS	N BALANCE +	N BALANCE −	WEIGHT IN LBS.
May	27	165	-	26.40	17.6	1.3	18.9	7.50		120
	28	165	-	26.40	18.5	1.8	20.3	6.10		
	29	165	-	26.40	17.0	nil	17.0	9.40		
	30	165	-	26.40	14.00	3.3	17.3	9.10		
	31	165	-	26.40	8.00	2.6	10.6	15.80		
June	1	165	-	26.40	11.50	nil	11.50	14.90		
	2	165	-	26.40	12.60	3.8	16.40	8.0		
	3	165	-	26.40	12.40	nil	12.40	14.0		120.8
	4	165	-	26.40	15.50	nil	15.50	10.90		
	5	165	-	26.40	18.0	1.4	19.40	7.0		
	6	165	-	26.40	15.0	0.9	15.90	10.50		
	7	165	-	26.40	6.0	1.7	7.7	18.70		
	8	165	-	26.40	15.3	nil	15.3	11.10		
	9	165	-	26.40	16.3	1.6	17.9	8.50		
	10	165	-	26.40	10.7	nil	10.7	15.70		126.5
	11	165	-	26.40	15.5	4.3	19.8	6.60		
	12	165	-	26.40	12.5	1.4	13.9	12.50		

CASE No. 7.

Height: 5 ft. 5 ins.

DATE	PROT.	PN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N EXCRETION	N BALANCE +	N BALANCE -	WT. DRIED STOOL	% FAT IN STOOL	FAT EXCRETED	WEIGHT IN LBS.
June 10	145	-	36	319	2180	23.20	1555	9.89	1.10	10.99	12.21		18.08	16.7	3.03	101.5
11	145	-	36	329	2220	23.20	2795	12.41	2.62	15.03	8.17		39.11	11.0	4.30	
12	145	-	36	329	2220	23.20	1040	6.74	1.89	8.63	14.67		30.31	12.9	4.93	
13	49	-	38	333	2270	23.84	1520	11.43	1.88	13.31	10.53		31.46	17.2	5.04	
14	64	-	19	141	991	10.24	1260	11.79	1.18	12.97		2.73	not estimated			
15	145	-	36	329	2220	23.20	1120	7.21	4.48	11.69	11.51		196	15.1	29.50	
16	145	-	36	329	2220	23.20	2760	14.46	0.78	15.22	7.98		45.67	12.4	5.70	
17	145	-	36	329	2220	23.20	1910	12.68	2.98	15.66	7.54		103.34	20.8	21.45	102.3
18	145	-	36	329	2220	23.20	1950	12.33	6.92	19.25	3.95		166.6	37.1	61.64	
19	145	-	36	329	2220	23.20	1680	10.48	nil	10.48	12.72		nil			
20	150	-	80	330	2640	23.20	2130	13.97	nil	13.97	10.03		nil			
21	150	-	80	330	2640	24.00	1750	8.82	3.74	12.56	11.44		68.39	13.11	8.96	
22	150	-	80	330	2640	24.00	2450	15.68	1.82	17.52	6.48		33.65	27.5	9.24	
23	150	-	80	330	2640	24.00	2060	13.76	nil	13.76	10.24		nil			
24	150	-	80	330	2640	24.00	2500	17.30	7.52	24.82		0.82	186.4	25.7	47.8	105.8
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CASE No. 7 (Contd.)

DATE	PROT.	PN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N EXCRETION	N BALANCE +	N BALANCE -	WT. DRIED STOOL	% FAT IN STOOL	FAT EXCRETED	WEIGHT IN LBS.
June 25	150	-	80	330	2640	24.00	1890	12.93	nil	12.93	11.07		nil			
26	150	-	80	330	2640	24.00	2700	13.40	nil	13.40	10.60		nil			
27	150	-	80	330	2640	24.00	2435	15.80	nil	15.80	8.20		nil			
28	150	-	80	330	2640	24.00	1815	12.78	1.61	14.39	9.61		31.35	33.3	10.44	
29	150	-	80	330	2640	24.00	1640	12.00	2.68	14.68	9.32		78.11	38.5	30.05	
30	150	-	80	330	2640	24.00	2660	14.30	2.32	16.62	7.38		not estimated			
July 1	150	-	80	330	2640	24.00	2450	19.50	2.72	23.22	0.78		73.68	35.7	26.30	107.5
2	150	-	80	324	2616	24.00	1690	15.30	1.99	17.29	6.71		46.29	33.3	15.43	
3	150	-	80	330	2640	24.00	1990	16.40	4.27	20.67	3.33		97.98	38.4	37.60	
4	150	-	80	330	2640	24.00	1930	14.60	2.00	16.60	7.40		56.09	28.7	16.10	
5	150	-	80	330	2640	24.00	3620	28.90	2.32	31.22		7.22	37.14	27.1	10.05	
6	150	-	80	330	2640	24.00	2460	19.10	3.05	22.15	1.85		81.10	36.3	29.30	
7	150	-	80	330	2640	24.00	2390	19.10	1.80	20.90	3.10		40.01	35.5	14.20	
8	150	-	80	330	2640	24.00	1890	17.70	1.97	19.67	4.33		44.72	31.0	13.90	109.3
9	150	-	80	330	2640	24.00	2170	18.60	2.98	21.58	2.42		65.78	32.6	22.10	
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CASE: No. 7 (Contd.)

DATE	PROT.	PRO-NUTRIN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N EX-CRE-TED	N BALANCE + −	WT. DRIED STOOL	% FAT IN STOOL	FAT EX-CRE-TION	WEIGHT IN LBS.
July 10	150	-	80	330	2640	24.00	2070	16.25	1.42	17.67	6.33	44.39	26.7	11.80	
11	103	55	81	326	2665	23.08	2150	17.00	3.18	20.18	2.90	87.73	31.4	27.60	
12	103	55	81	326	2665	23.08	1720	15.00	1.85	16.85	6.23	38.71	32.2	12.85	
13	103	55	81	326	2665	23.08	2240	17.65	2.07	18.72	4.36	58.90	34.8	20.30	
14	103	55	81	326	2665	23.08	2356	16.44	1.59	18.03	5.05	38.30	35.4	13.50	
15	103	55	81	326	2665	23.08	2650	15.90	1.26	17.16	5.92	32.90	39.1	12.85	113
16	103	55	81	326	2665	23.08	2350	15.80	2.80	18.60	4.48	69.42	not estimated		
17	103	55	81	326	2665	23.08	2600	15.60	1.91	17.51	5.51	53.79	34.7	18.68	
18	103	55	81	326	2665	23.08	2510	13.85	2.29	16.14	6.94	51.20	39.7	20.33	
19	103	55	81	326	2665	23.08	3175	18.42	1.79	20.21	2.87	72.81	17.7	12.92	
20	103	55	81	326	2665	23.08	2790	14.60	0.84	15.44	7.64	24.44	25.7	6.52	
21	103	55	81	326	2665	23.08	2230	15.61	2.02	17.63	5.45	67.72	26.7	18.08	
22	103	55	81	326	2665	23.08	2680	15.60	1.08	16.68	6.40	25.88	34.8	9.04	113.5
23	103	110	81	326	2885	29.68	2360	19.20	1.44	20.64	9.04	34.80	31.8	11.08	
24	103	110	81	326	2885	29.68	2300	22.60	3.08	25.68	4.00	76.00	27.2	19.00	
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CASE: NO. 7 (Contd.)

DATE	PROT.	PRO-NUTRIN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N EXCRETION	N BALANCE +	N BALANCE −	WT. OF DRIED STOOL	% FAT IN STOOL	FAT EXCRETION	WT. IN LBS.
July 25	103	110	81	326	2885	29.68	2400	21.90	2.48	24.38	5.30		57.75	21.2	12.30	
26	103	110	81	326	2885	29.68	2220	19.70	1.74	21.44	8.24		54.80	23.0	12.60	
27	103	110	81	326	2885	29.68	2450	22.10	2.42	24.52	5.16		54.91	26.6	14.60	
28	103	110	81	326	2885	29.68	2150	22.30	1.70	24.00	5.68		31.30	20.0	6.25	
29	103	110	81	326	2885	29.68	2450	20.20	3.66	23.86	5.82		77.46	16.2	12.45	
30	103	110	81	326	2885	29.68	2500	27.10	1.67	28.77	0.91		29.84	22.6	7.85	116.9
31	103	110	81	326	2885	29.68	3500	28.70	3.48	32.18		2.50	72.71	16.6	11.92	
Aug. 1	103	110	81	326	2885	29.68	1630	23.40	3.22	27.62	2.06		66.89	17	11.35	
2	103	110	81	326	2885	29.68	2720	26.20	3.44	29.64	0.04		69.74	14.9	10.35	

CASE No. 8 Height: 5 ft. $5\frac{3}{4}$ ins.

DATE		PROT.	PRO-NUTRIN	N INTAKE	URINE N	STOOL N	N EXCRETION	N BALANCE +	N BALANCE -	FAT INTAKE	STOOL FAT	% FAT IN STOOL	WEIGHT IN LBS.
July	24	114	-	18.24	14.84	3.08	17.92	0.32		94	24.2	34.3	110.2
	25	114	-	18.24	14.79	3.86	18.65		0.41	94	30.2	39.7	
	26	114	-	18.24	12.60	5.00	17.60	0.64		94	42.2	29.8	
	27	114	-	18.24	15.48	3.40	18.88		0.64	94	21.1	28.7	
	28	114	110	31.44	14.80	4.60	19.40	12.04		94	48.1	46.6	
	29	114	110	31.44	21.95	5.70	27.65	3.79		94	30.3	39.9	110.2
	30	114	110	31.44	17.78	4.98	22.76	8.68		94	41.2	44.8	
	31	114	110	31.44	20.50	6.10	26.60	4.84		94	48.3	46.2	
Aug.	1	101	110	29.36	22.50	6.28	28.78	0.58		78	76.0	48.7	
	2	114	110	31.44	27.40	5.52	32.92		1.58	94	48.5	38.1	
	3	114	110	31.44	23.10	4.92	28.02	3.42		94	32.8	58.4	
	4	114	110	31.44	22.80	3.88	26.68	4.76		94	33.0	35.1	
	5	112	110	31.12	26.60	3.64	30.24	0.88		94	43.5	47.6	113.8
	6	/											

CASE No. 8 (Contd.)

DATE		PROT.	PRO-NUTRIN	N INTAKE	URINE N	STOOL N	N EXCRETION	N BALANCE +	N BALANCE -	FAT INTAKE	STOOL FAT	% FAT IN STOOL	WEIGHT IN LBS.
Aug.	6	109	110	30.64	25.85	5.30	31.15		0.51	90	55.6	46.7	
	7	107	110	30.32	21.70	6.28	27.98	2.34		92	62.4	48.4	
	8	107	110	30.32	24.28	5.24	29.52	0.80		92	64.4	53.1	
	9	107	Casein 110	30.32	26.20	12.60	38.80		8.48	92	121.6	44.8	
	10	107	Casein 110	30.32	19.00	4.42	23.42	6.90		92	33.0	35.0	
	11	107	Pronutrin 110	30.32	22.15	6.00	28.15	2.17		92	25.3	25.5	111.0

CASE No. 9.

Height 5 ft. 4 ins.

DATE		PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	N. INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
Jan.	24	94		121	404	2281	15.05	1450	14.04	nil	14.04	1.01		92.75
	25	89		129	228	2290	14.24	1295	12.91	0.11	13.02	1.22		
	26	70		114	210	2146	11.02	1590	9.34	nil	9.34	1.68		
	27	74	50	134	206	2526	17.84	850	12.88	2.48	15.36	2.48		89
	28	61	50	92	133	1804	15.76	780	12.84	nil	12.84	2.92		
	29	59		78	220	1818	9.44	1150	8.75	nil	8.75	0.69		
	30	42		50	161	1262	6.72	1445	12.34	nil	12.34		5.62	
	31	86		90	226	2058	13.78	1270	15.05	nil	15.05		1.27	
Feb.	1	90		117	247	2401	14.40	850	11.10	2.68	13.78	0.62		
	2	61	60	90	189	1820	16.96	lost		nil				
	3	70	60	111	161	2163	18.40	955	17.05	0.26	17.31	1.09		
	4	86	60	103	221	2395	20.96	930	16.08	2.0	18.08	2.88		89
	5	82	60	112	201	2380	20.32	1280	17.34	1.15	18.49	1.83		
	6	72	66	102	266	2504	18.88	1350	15.20	0.75	15.95	2.93		
	7	89	60	102	176	228	21.44	1280	18.53	nil	18.53	2.91		
	8	50	60	91	168	1931	15.20	1130	16.63	2.24	18.87		3.61	
		25mg. testesterone daily												
	9	49	60	64	150	1612	15.04	960	17.20	1.86	19.06		4.02	
	10	59	60	70	163	1758	16.64	930	15.37	nil	15.37	1.27		89.5

CASE No. 10.

Height 5 ft. 6 ins.

DATE	PROTEIN	PRONUTRIN	FAT	CARBO.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	TOTAL N EXCRETION	N BALANCE +	N BALANCE -	WEIGHT IN LBS.
Feb. 6	28	100	26	86	1090	16.08	1180	9.01	1.26	10.27	5.81		100
7	33	100	21	75	1021	17.28	1910	18.68	1.74	20.42		3.14	
8	20	100	21	77	977	15.20	1280	16.16	4.40	20.56		5.36	
9	18	100	10	55	782	14.88	1280	16.09	nil	16.09		1.21	
10	13	100	12	66	824	14.08	1750	16.24	nil	16.24		2.18	100.5
11	8	100	6	168	1158	13.28	2110	16.42	0.37	16.79		3.51	
12	15	50	14	140	980	8.4	1490	11.92	0.33	12.25		3.85	
	25mg. testesterone daily												
13	31		20	70	584	4.96	2080	7.99	0.87	8.86		3.90	
14	58		42	107	1038	9.28	2030	5.85	0.76	6.61	2.67		
15	46		57	110	1133	7.36	1565	8.01	0.04	9.05		1.69	
16	42		43	74	851	6.72	1810	6.41	1.00	7.41		0.69	99
17	45		47	134	1139	7.20	930	7.23	1.16	8.39		1.19	
18	56		43	100	1011	8.95	1120	7.48	1.34	8.82	0.14		
19	56		56	126	1232	8.96	1400	9.16	0.65	9.81		0.85	
20	47		40	92	916	7.52	790	7.96	0.04	8.00		0.48	
21	51	1000cc. Casydrol.	46	100	1018	14.29	1210	7.26	0.90	8.16	6.13		
22	59	750cc. Casydrol.	42	122	1102	14.05	3700	13.10	0.53	13.63	0.42		
	Testesterone stopped												
23	61		73	139	1457	9.75	2490	4.38	nil	4.38	5.37		
24	49		41	148	1157	7.84	2520	7.66	nil	7.66	0.18		
25	53		50	152	1270	8.48	3350	8.15	0.36	8.51		.03	
26	50		50	157	1278	8.00	2400	5.76	1.46	7.22	0.78		
27	48		53	162	1317	7.68	2600	7.69	2.12	9.81		2.23	
28	56		50	154	1290	8.96	2260	8.60	0.36	8.96	0		
Mar. 1	53		47	133	1167	8.50	1970	10.16	0.71	10.87		2.37	
2	56		46	140	1252	8.96	2270	10.26	0.32	10.58		1.62	
3	56		49	140	1225	8.96	2160	7.01	0.61	7.62	1.34		98
4	55		49	144	1237	8.80	2510	10.30	0.70	11.00		2.20	
5	54		52	136	1228	8.64	2010	10.93	0.70	11.63		2.99	

CASE No. 11.

Weight: 9 st. 12 lbs. Height: 5 ft. 9 ins.

	INTAKE						OUTPUT				N. BALANCE	
Date.	Vol. of Casydrol in ml.	Prot.	Fat.	Carbo-hydrate.	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	N Loss.	+	-
1947. July 13.		125	96	388	2916	20	2020	14.10	2.01	16.11	3.89	
14.		125	96	388	2916	20	1900	13.90	Nil	13.9	6.10	
15.		125	96	388	2916	20	1470	14.38	2.75	17.13	2.87	
16.		125	96	388	2916	20	2250	17.15	3.11	20.26		0.26
17.		125	96	388	2916	20	1830	14.98	1.89	16.87	3.13	
18.		125	96	388	2916	20	2140	19.98	1.95	21.93		1.93
19.		125	96	388	2916	20	2020	13.80	2.29	16.09	3.71	
20.		125	96	388	2916	20	2080	19.70	3.52	23.22		3.22
21.		125	96	388	2916	20	1380	12.75	1.75	14.50	5.50	
22.	1080	125	96	388	2916	27.08	4010	23.65	2.85	26.50	0.58	
23.	1080	125	96	388	2916	27.08	2670	16.82	2.80	19.62	7.46	
24.	150	125	96	388	2916	20.99	2310	19.00	2.61	21.61		0.62
25.	1080	119	90	388	2916	26.12	2460	16.40	2.17	18.57	7.55	
26.		119	90	388	2916	19.04	1650	17.16	3.21	20.37		1.33
27.		125	96	388	2916	20	1770	17.39	2.43	19.82	0.18	
28.		125	96	388	2916	20	1800	16.39	2.83	19.22	0.78	
29.		125	96	388	2916	20	2320	19.72	1.79	21.51		1.51
30.		125	96	388	2916	20	2050	18.45	3.11	21.56		1.56

CASYDROL INFUSION (NITROGEN DISTRIBUTION)

		I N T A K E						U R I N E			
			CASYDROL								
Date.		Plasma Amino N. mg%	N.	Amino Acid N.	Peptide N.	Food N.	Total N.	Total N.	Urea N.	Amino Acid N.	Peptide N.
1947. July 18.						20	20	19.98	16.94	0.70	1.67
19.						20	20	13.80	11.72	0.73	1.73
20.						20	20	19.70	17.10	0.58	1.28
21.						20	20	12.75	11.02	0.41	-
22.	11.30 hrs.	5.6								0.53	
	13.30 hrs.	6.9								0.27	
	14.30 hrs.	6.1								0.33	
	15.30 hrs.	5.6								-	
	16.30 hrs.	5.4								0.23	
	20.30 hrs.	5.6								1.12	
	- 08 hrs.									0.77	
	Total		7.08	3.56	1.74	20	27.08	23.65	Lost	3.25	2.45
23.		5.6	7.08	3.56	1.74	20	27.08	16.82	13.32	1.55	3.15
24.		5.6	0.99	0.49	0.25	20	20.99	19.00	15.76	0.92	2.40
25.		5.6 7.8	7.08	3.56	1.74	19.04	26.12	16.40	12.30	1.17	0.80
26.						19.04	19.04	17.16	14.40	0.92	0.60
27.						20	20	17.39	14.27	0.73	0.90
28.		5.6				20	20	16.39		0.88	

CASE No. 12.

DATE	INTAKE			URINE			
	VOL. OF CASYDOL in ml.	CASYDOL N.	AMINO ACID N.	VOLUME	TOTAL N	AMINO ACID N.	CHLORIDE (as NaCl)
1947 July 3				1145	6.64	0.33	3.37
4				1050	7.66	0.43	3.78
5				850	8.67	0.38	3.94
6				740	8.62	0.34	2.78
7	1620	10.65	5.35	627	7.49	0.53	0.59
8	540	3.55	1.78	965	12.40	0.54	0.66
9	540	3.55	1.78	965	8.94	1.01	0.81
10				1160	8.98	1.02	0.19
11				1290	5.26	0.39	0.21

CASE NO. 13.

	BLOOD CHEMISTRY				INTAKE				URINE					N. BALANCE	
Date.	Plasma Amino Acid N. mg %	Plasma Urea N mg%	Albumin in g%.	Globulin in g%.	Vol. of Casydrol in ml.	Total N.	Amino Acid N.	Peptide N.	Vol.	Total N.	Urea N.	Amino Acid N.	Peptide N.	+	-
June 20.					Nil	Nil			390	5.46		0.18			5.46
21.	5.1 (1) 6.6 (2)	21 21	3.50	3.60	2160	14.20	7.14	3.46	1230	8.98	5.70	0.58	2.48	5.19	
22.	5.2	20			2160	14.20	7.14	3.46	1570	6.90	4.96	0.66	1.09	7.27	
23.	4.8	20			2160	14.20	7.14	3.46	2175	12.68	5.94	1.20	5.48	1.49	
24.	4.9	15			1080	7.08	3.56	1.73	1290	9.58	5.74	1.52	3.22		2.50
25.					1780	11.70	5.85	2.85	1990	13.98	8.35	1.26	3.71		2.30
26.	4.9	19	2.40	2.90	270	1.77	0.89	0.43	1190	9.60	6.52	0.39	2.71		7.83
27.					Nil				800	5.68	3.90	0.18	1.46		5.68
28.					1620	10.65	5.35	2.59	790	6.13	3.94	0.40	2.07	3.50	
29.					1080	7.08	3.57	1.73	1900	10.50	6.16	0.44	3.52		3.42

CASE No. 14.

DATE		INTAKE					OUTPUT					N BALANCE	
		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-
Dec.	2	104	115	284	2587	16.64	940	14.06	1.98	-	16.04	0.6	
	3	104	115	284	2587	16.64	980	14.03	0.79	-	14.82	1.82	
	4	107	115	295	2643	17.12	1650	13.8	0.3	lost	14.1	3.02	
	5	Operation*					660	5.48		3.92	9.40		9.40
	6					nil	1100	18.26	nil	2.57	20.63		20.63
	7	18	17	48	417	2.88	500	11.18	nil	1.52	12.7		9.82
	8	19	18	49	434	3.04	890	23.7	nil	nil	23.7		20.66
	9	33	38	86	818	5.28	1230	30.46	nil	nil	30.46		25.18
	10	43	44	82	896	6.87	1090	17.96	nil	nil	17.96		11.09
	11	65	70	165	1550	10.48	970	15.66	4.4	nil	20.06		9.58
	12	87	93	209	2021	12.15	670	9.36	nil	nil	9.36	2.79	
	13 /												

* 930 ml blood transfused ≡ 17.78 g.N.
blood lost ≡ 16.6 g.N.
Stomach resected contained 1.98 g.N.

CASE NO. 14.(Contd.)

		INTAKE					OUTPUT					N BALANCE	
DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-
Dec.	13	87	93	209	2021	12.56	885	10.5	2.22	nil	12.72		0.16
	14	77	86	228	1994	12.32	320?	4.94	2.16	-			
	15	77	108	260	1994	10.00	1190	10.41	1.4	-	11.81		1.81
	16	102	108	260	2420	16.32	845	4.9	1.92	-	6.82	9.5	
	17	102	108	260	2420	16.32	650	7.78	0.68	-	8.46	7.76	
	18	102	108	260	2420	16.32	LOST						
	19	102	108	260	2420	16.32	1130	11.82	0.94		12.76	3.56	

CASE No. 15 Height 5 ft. 5 ins.

DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	BALANCE +	BALANCE -	BODY WT. in LBS.
Jan.	7	79	84	259	2108	12.64	1850	12.5	-	-	12.5	0.14		112.25
	8	79	84	259	2108	12.37	960	8.68	2.7	2.32	13.7		1.33	
	9	Operation*					660	6.89		3.02	9.91		9.91	
	10	16	19	24	331	2.56	900	13.00	nil	4.36	17.36		14.8	
	11	22	21	70	557	3.52	700	12.63	nil	-	12.63		9.11	
	12	23	23	66	563	3.68	530	11.82	lost	-	11.82+		8.14†	
	13	36	42	93	594	5.75	680	16.19	nil	-	16.19		10.44	
	14	44	41	86	885	7.04	675	14.97	1.65	-	16.62		9.58	
	15	60	74	195	1685	9.6	530	12.45	3.42	-	15.87		6.27	
	16	60	74	195	1685	9.6	640	12.37	1.06	-	13.43		3.83	
	17	60	74	195	1685	9.6	856	13.42	0.48	-	13.9		4.3	
	18 /													

* 785 ml blood transfused ≡ 20.15 g. N.
blood lost ≡ 9.66 g. N.
Stomach resected contained 4.25 g. N.

CASE No. 15 (Contd.)

DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	BALANCE +	BALANCE −	BODY WT. in LBS.
		INTAKE					OUTPUT					BALANCE		
Jan.	18	60	74	195	1685	9.6	1040	13.23	0.99	-	14.22		4.62	
	19	60	74	195	1685	9.6	900	11.4	2.74	-	14.14		4.54	
	20	79	79	238	1979	12.64	1270	10.89	1.57	-	12.46	0.18		
	21	86	84	266	2164	13.78	1710	13.9	2.8	-	16.7		2.92	
	22	85	84	250	2096	13.6	1515	14.73	1.37	-	16.1		2.5	103.25
	23	86	84	266	2164	12.43	830	8.12	2.2	-	10.32	2.11		
	24	86	84	266	2164	13.78	880	10.71	0.7	-	11.41	2.37		

CASE No. 16 Height 5 ft. 5 ins.

	INTAKE					OUTPUT					BALANCE			
DATE	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.
1947 Jan. 13						940	11.60	-		11.60			110.75	
14	81	97	292	2385	12.95	1140	11.12	1.09		12.21	0.74			
15	81	97	292	2385	12.95	880	9.13	0.62		9.75	3.20			
16	81	97	292	2385	12.95	1510	8.49	1.24	s.w.o. 0.35	10.80	2.15		112.0	
Operation* 17	nil	nil	nil	nil	nil	1170	5.05	nil	1.07	6.12		6.12		99.4
18	10	11	194	891	1.60	880	10.17	nil	2.36	12.53		10.90		100.0
19	12	13	90	525	1.92	790	8.97	nil	1.24	10.21		8.29		100.0
20	30	35	67	703	4.80	1270	12.36	nil		12.36		7.56		101.4
21	40 approx.	-	-	-	6.40	610	11.35	4.87		16.22		10.00		100.2
22	46	55	137	1317	7.41	870	9.50	2.58		12.08		4.67	105.0	99.4
23	67	61	135	1357	10.80	710	7.30	0.68		7.98	2.83			
24 /														

* 730 ml blood transfused ≡ 24.31 g. N.
blood lost ≡ 6.94 g. N.
Stomach resect contained 2.14 g. N.

CASE No. 16 (Contd.)

		INTAKE				OUTPUT					BALANCE			
DATE	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.
1947 Jan. 24	67	69	178	1581	10.80	780	9.61	0.76		10.37	0.43			
25	62	64	171	1508	9.93	730	10.19	1.66		11.85		1.92		
26	62	64	178	1536	9.93	1470	12.25	nil		12.25		2.32		
27	64	65	194	1617	10.25	1290	10.00	1.04		11.04		0.79	102.6	
28	75	83	238	2000	12.00	1450	11.13	3.30		14.43		2.43		
29	75	83	238	2000	12.00	1310	10.30	nil		10.30	1.70			
30	75	83	238	2000	12.00	1060	8.51	nil		8.51	3.49		101.75	

CASE NO.17.

Date	Prot.	Fat	Carb.	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	Suct: ion N.	N. Loss	+	-	Amino Acid N.	Body Wt. lbs.	Body Temp. °F.	Urine Cl. (as NaCl)
	INTAKE.					OUTPUT.					BALANCE.					
1947																
July 7	74	46	182	1438	11.84	820	12.18	0.85		13.03		1.19	0.47			1.05
8	85	102	257	2286	13.60	1650	14.14	2.60		16.74		3.14	0.67			4.29
9	109	108	270	2460	17.40	1400	12.22	1.20		13.42	3.98		0.55			5.44
OPERATION X																
10	NIL	NIL	48	192	NIL	158	2.04	NIL	2.38	4.42		4.42	0.09			0.25
11	1.9	2.4	75	328	0.30	1420	21.20	NIL	1.24	22.44		22.14	0.99			2.53
12	2.4	3.6	100.5	444	0.40	lost		NIL					lost		99.1	-
13	9.9	12	63	400	1.50	790	13.10	NIL		13.10		11.60	0.62		99.0	0.83
14	18.8	21.6	19.5	347	3.00	890	16.14	NIL		16.14		13.14	0.69		100.4	2.65
15	87	79	213	1911	13.90	760	15.90	2.12		18.02		4.12	0.43			1.69
16	65	81	179	1705	10.40	640	9.60	1.27		10.87		0.47	0.58			3.83
17	70	78	222	1870	11.20	1000	14.70	NIL		14.70		3.50	1.24			9.40
18	74	75	230	1891	11.82	1650	11.76	NIL		11.76	0.06		1.30			10.32
19	66	72	169	1588	10.56	1110	13.30	NIL		13.30		2.74	lost		100.6	6.22
20	86	91	196	1947	13.26	1240	22.65	1.41		24.06		10.70	1.78		99.8	9.65
21	88	87	242	2103	14.08	1240	17.22	NIL		17.22		3.14	1.24			4.45
22	60	82	232	1906	9.60	1510	15.50	1.27		16.77		7.17	2.18		99.1	9.64
23	101	107	268	2439	16.16	1190	13.04	NIL		13.04	3.12		1.24		101.4	5.40
24	101	108	264	2432	16.16	2150	16.50	NIL		16.50		0.34	2.42		99.4	4.64
25	87	102	270	2346	13.92	1610	12.88	0.18		13.06	0.86		2.14			3.77
26	102	108	270	2460	16.32)	2670	26.65	NIL		13.32	3.00		3.15)			) 14.16
27	100	108	251	2376	16.00)			1.22		14.52	1.46		)			)
28	92	105	238	2265	14.72	1120	14.51	NIL		14.51	0.21		1.12			3.42
29	98	112	245	2380	15.68	1720	14.28	0.95		15.23	0.45					5.63
30	89	102	204	2090	14.26	1050	10.36	NIL		10.36	3.90					5.38

X 950 ml. blood transfused = 21.95 g. N.
blood lost contained = 27.98 g.N.
Stomach resected contained = 4.09 g. N.

CASE: NO. 18.

		INTAKE					OUTPUT					BALANCE				
DATE	VOL. CASY-DRD. ML.	PROT.	FAT	CARB.	CAL-OR-IES	N IN-TAKE	URINE VOL.	URINE N	STOOL N	SUC-TION-N	N LOSS	+	-	BODY WT. LBS.	BODY TEMPER-ATURE OF	URINE CL. (as NaCl)
1948																
Feb. 14		105	106	299	2570	16.80	1080	13.87	2.50		16.37	0.57		114.6		
15		105	106	299	2570	16.80	1600	12.7	nil		12.70	4.10		113.5		
16		105	106	299	2570	16.80	1810	12.67	3.04		15.71	1.09		113.5		
17		105	106	299	2570	16.80	1180	14.10	nil		14.10	2.70		113.9		11.8
18		105	106	299	2570	16.80	2240	16.40	nil		16.40	0.40		115.5		9.75
19		105	106	299	2570	16.80	2880	15.00	146	0.14	16.60	0.20		114.8		6.8
20		105	106	299	2570	14.24	3230	13.83	2.76	0.42	17.01		2.77	115.25		6.9
OPERATION*																
21							920	4.86	nil	1.71	6.57		6.57	115.25		3.5
22	620	24	nil	31	220	3.80	1290	16.61	nil	0.17	17.78		13.98		102	3.42
23		nil	nil	96	384	nil	720	16.55	nil	1.85	18.40		18.40		99	0.6
24		nil	nil	72	288	nil	740	19.45	nil	0.08	19.53		19.33	110.75		0.74
25		2	2	16	80	0.32	630	16.57	nil	-	16.57		16.25	112.0		0.69
26		15	18	23	314	2.40	760	16.30	nil	-	16.30		13.90	112.0		0.87
27 /																

* Footnote on following page

CASE: NO. 18 (CONTD.)

		INTAKE							OUTPUT			BALANCE				
DATE	VOL. CASY-DRD.ML.	PROT.	FAT	CARB.	CAL-OR-IES	N IN-TAKE	URINE VOL.	URINE N	STOOL N	SUC-TION N	N LOSS	+	−	BODY WT. LBS.	BODY TEMPER-ATURE °F	URINE CL. (as NaCl)
Feb. 27		17	11	84	503	2.72	940	10.90	2.00	-	12.90		10.18	110.75		0.98
28		43	48	141	1168	7.04	1150	12.10	nil	-	12.10		5.06	105.25		1.55
Mar. 1		46	44	114	1034	7.65	870	9.72	3.88		13.60		5.95	104.0		1.24
2		60	75	190	1675	9.45	970	10.90	nil		10.90		1.45	105.0		1.82
3		65	88	184	1788	10.40	1400	12.38	1.48		13.86		3.46	105.0		3.55
4		66	88	203	1868	10.56	1080	9.92	0.90		10.82		0.26	105.0		5.03
5		66	88	203	1868	10.56	1380	9.55	0.26		9.81	0.75		106.0		9.95
6		66	88	203	1868	10.56	1620	10.04	0.54		10.58		0.02	105.5		6.8
7		62	84	206	1828	9.92	850	7.31	1.66		8.96	0.96		106.25		4.17
8		74	81	208	1857	11.85	1360	8.84	1.68		10.52	1.33		104.25		5.37
9		73	81	206	1845	11.68	830	7.14	0.68		7.82	3.86		104.75		5.65

* 980 ml blood transfused ≡ 22.95 g N
blood lost ≡ 27.1 g N
Stomach resect contained 3.44 g N

CASE No. 19.

Height: 5 ft. 8 ins.

		INTAKE					OUTPUT					N BALANCE				
DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	TEMP. °F	URINE CL. (asNaCl)
1947 Mar.	27	92	97	207	2045	14.72	1030	9.54	0.96		10.50	4.22		113.0		7.91
	28	75	83	226	1951	12.00	910	10.42	2.93		13.35		1.35	112.6		5.79
	29	75	83	226	1951	12.00	1090	12.17	nil		12.17		0.17	113.0		5.12
	30	65	72	186	1652	10.40	790	11.98	2.35		14.33		3.93	113.6		4.06
	31	62	70	158	1510	9.92	940	8.62	1.12		9.74	0.18		113.3		5.51
Apr.	1	65	72	181	1632	10.40	1510	7.65	nil		7.65	2.75		112.8		6.49
	2	75	83	226	1951	12.00	1940	8.54	lost	1.08	9.62	+		113.25		6.68
	3	Operation*		40	160		220	2.25	nil	0.11	2.36				99	4.57
	4			60	240	nil	1780	17.02	nil	0.84	17.86		17.86			5.41
	5			20	80	nil	550	8.03	nil	0.11	8.14		8.14		99.6	1.53
	6	2	2	43	192	0.32	900	12.64	nil		12.64		12.32			1.30
	7 /															

* 1000 ml blood transfused ≡ 26.0 grm. N.
blood lost ≡ 25 grm. N.
Stomach resected contained 5.41 grm. N.

CASE No. 19. (Contd.)

			INTAKE					OUTPUT			N BALANCE				
DATE	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	−	BODY WT. in LBS.	TEMP. $^{\circ}F$	URINE CL. (as NaCl)
1947 Apr. 7	27	32	41	520	4.32	810	12.01	nil		12.01		7.69			2.72
8	11	13	19	247	1.76	950	12.77	nil		12.27		10.51	112	99	6.13
9	67	80	200	1788	10.72	1200	11.31	nil		11.31		0.59	112		8.16
10	67	80	208	1838	10.72	1470	9.35	nil		9.35	1.37		111.9		7.99
11	67	82	208	1838	10.72	1480	8.62	6.36		14.98		4.26	111.8		
12	67	82	200	1806	10.72	1610	5.44	nil		15.44	5.28		111.25		
13	67	82	200	1806	10.72	840	6.47	3.78		10.25	0.47		110.75		
14	67	82	200	1806	10.72	1540	10.32	nil		10.32			110.0		

CASE No. 20.

	INTAKE					OUTPUT					BALANCE.		URINE
Date.	Prot.	Fat	Carbo-hydrate	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	Suction N.	N. Loss	+	-	Chloride (as NaCI)
1947													
March 3	109	117	258	2521	17.04	960	10.32	0.65		10.97	6.07		7.70
4	116	120	322	2832	18.58	980	12.50	Nil		12.50	6.08		7.67
5	116	120	322	2832	18.58	920	10.99	0.76		11.75	6.73		9.20
6	16	120	322	2832	18.58	1150	11.07	1.36	0.71	13.14	5.34		8.25
7	OPERATION X		80	320	-	400	4.84	Nil	0.89	20.85			2.04
8	-		60	240	Nil	1050	16.02	Nil	0.70	16.72		16.72	4.37
9	-		60	240	Nil	950	15.23	Nil	0.19	15.42		15.42	3.42
10	7	8	10	140	1.12	770	15.56	Nil	0.09	15.65		14.53	0.80
11	10	12	15	184	1.60	630	14.53	2.88		16.41		14.81	1.23
12	29	49	105	977	4.63	680	14.08	Nil		14.08		9.45	1.86
13	65	71	175	1599	10.40	710	12.20	Nil		12.20		1.80	2.80
14	65	71	176	1603	10.40	870	13.17	1.10		14.27		3.87	)
15	65	71	176	1603	10.40	760	11.33	Nil		11.33		0.93	) Lost
16	65	71	176	1603	10.40	870	12.35	Nil		12.35		1.95	)
17	65	71	176	1603	10.40	760	10.32	Nil		10.32	0.08		6.25
18	65	71	176	1603	10.40	700	10.22	1.47		11.69		1.29	5.50
19	65	71	176	1603	10.40	810	9.90	Nil		9.90	0.5		6.03
20	87	71	206	1982	13.92	880	9.90	0.66		10.56	3.32		6.75

X 500 c.cs. Blood transfused = 13.32 g N.
Blood lost contained 12.60 g N.
Stomach resected contained 2.52 g N.

CASE No. 21.

	INTAKE					OUTPUT				N.BALANCE		
Date. 1947.	Prot.	Fat.	Carbo-hydrate.	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	N. Loss.	+	-	Urine Chloride (as NaCI)
Nov. 27.	90	100	310	2500	14.40	1030	10.72	1.40	12.12	2.28		10.16
28.	90	100	310	2500	14.40	1440	15.02	2.16	17.18		2.78	13.91
29.	90	100	310	2500	14.40	1340	12.06	0.79	12.85	1.55		10.72
30.	90	100	310	2500	14.40	1420	13.40	0.42	13.84	0.64		11.84
Dec. 1.	90	100	310	2500	14.40	800	10.28	1.64	11.92	2.48		7.16
2.	90	100	310	2500	14.40	750	11.80	Nil	11.80	2.60		6.82
3.	90	100	310	2500	14.40	1025	15.35	0.86	16.21		1.81	8.35
4.	90	100	310	2500	14.40	630	9.12	3.60	12.72	1.68		7.10
5.	OPERATION	-	20	80	-	1320	12.36	Nil	12.36			13.65
6.	-	-	80	320	-	530	13.80	Nil	13.80		13.80	5.25
7.		-	100	400	-	690	8.25	Nil	8.25		8.25	2.34
8.	15	18	24	318	2.40	860	18.50	Nil	18.50		16.10	1.41
9.	8	10	15	182	1.20	610	14.68	Nil	14.68		13.48	1.00
10.	16	19	27	343	2.56	660	15.58	Nil	15.58		13.02	0.71
11.	15	18	23	314	2.40	670	10.70	1.06	11.76		9.36	1.30
12.	12	14	19	250	1.92	600	13.85	0.66	14.51		12.59	1.50
13.	8	10	12	170	1.28	520	9.84	0.68	10.52		9.34	2.46
14.	20	25	31	429	3.20	790	12.90	1.10	14.00		10.80	6.33
15.	20	20	21	264	3.20	660	9.42	0.64	10.06		6.86	3.23
16.	28	24	49	524	4.40	525	6.97	1.30	8.27		3.87	5.00

Blood lost at operation contained 4.08 grs. N.

CASE NO. 22.

		INTAKE					OUTPUT				BALANCE		
DATE		PROT.	FAT	CARB.	CALS.	N	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	URINE CL.(as NaCl)
May	5	87	86	213	1974	13.92	1670	16.31	nil	16.31		2.39	11.56
	6	90	88	218	2024	14.4	910	12.08	0.74	12.82	1.58		4.53
	7	83	84	218	1960	13.28	760	10.88	nil	10.88	2.4		4.44
	8	83	84	218	1960	13.28	1120	8.15	2.54	10.69	2.59		6.79
	9	83	84	218	1960	13.28	920	8.25	nil	8.25	5.03		6.77
	10	83	84	218	1960	13.28	930	10.8	2.08	12.88	0.4		7.05
	11	Operation 21	22	81	606	3.46	640	3.1		3.3	0.16		2.64
	12	9	11	48	326	1.44	1060	18.85	nil	9.43		7.99	1.59
	13	9	11	48	326	1.44				9.43		7.99	
	14	10	14	69	442	1.6	440	11.02	nil	11.02		9.42	0.07
	15	26	32	93	764	2.56	370	8.9	2.84	11.74		9.18	0.067
	16	51	58	167	1397	8.16	880	19.92	nil	19.92		11.76	0.903
	17	68	62	175	1530	10.88	570	11.5	nil	11.5		0.62	1.39
	18	81	78	205	1846	12.96	810	13.86	2.04	15.92		2.96	4.08
	19 /												

CASE No. 22. (Contd.)

		INTAKE				OUTPUT				BALANCE		
DATE	PROT.	FAT	CARB.	CALS.	N	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	URINE CL. (as NaCl)
May 19	78	80	206	1856	12.48	1110	16.26	nil	16.28		3.80	6.48
20	71	65	196	1653	11.36	920	13.34	nil	13.34		1.98	4.69
21	82	84	213	1936	13.12	950	14.87	1.9	16.77		3.65	4.9
22	83	84	218	1960	13.28	970	15.9	nil	15.9		2.62	4.31
23	81	80	205	1864	12.96	1030	13.1	1.65	14.75		1.79	6.36
24	83	72	206	1804	13.28	1130	12.78	nil	12.78	0.5		6.44
25	81	80	208	1876	12.96	1330	14.5	nil	14.5		1.54	7.82
26	81	80	208	1876	12.96	1240	11.58	2.46	14.04		1.08	6.86
27	81	75	207	1827	12.96	980	12.35	nil	12.35	0.61		7.63
28	81	75	207	1827	12.96	2740	24.85	nil	12.42	0.54		15.38
29	83	84	209	1929	13.28			nil	12.43	0.85		
30	82	82	216	1930	13.12	910	12.82	0.6	13.42		0.3	6.25
31	82	84	218	1960	13.12	880	10.79	0.8	11.59	1.53		6.04

CASE No. 23.

DATE			INTAKE				OUTPUT				BALANCE		
DATE		PROT.	FAT	CARB.	CALS.	TOTAL N IN	URINE VOL.	URINE N	STOOL N	TOTAL N OUT	+	-	URINE CL. (as g NaCl)
May	9	91	107	174	2019	14.4	510	6.88	2.0	8.88	5.52		4.79
	10	37	51	87	955	4.22	615	10.23	nil	10.23		6.01	5.00
	11	24	40	56	680	3.84	450	8.08	nil	8.08		5.24	1.48
	12	82	86	135	1642	13.12	440	10.2	1.18	11.38	1.74		1.34
	13	62	76	154	1548	9.92	780	11.32	0.1	11.42		1.5	5.32
	14	89	111	191	2119	14.24	700	9.83	0.82	10.65	3.59		5.95
	15	76	99	162	1843	12.16	670	9.62	nil	9.62	2.54		5.39
	16	69	97	154	1765	11.04	290	4.34	2.02	6.36	4.68		2.03
	17	64	93	156	1717	10.24	710	8.4	nil	8.4	1.84		6.04
	18	56	82	152	1570	8.96	740	7.13	2.87	10.0		1.04	6.31
		operation*											
	19	13	19	96	607	2.58	700	4.9	nil	4.9		1.32	2.86
	20	8	15	35	307	1.28	420	6.53	nil	6.53		5.25	2.41
	21	24	20	84	612	3.84	385	6.56	nil	6.56		2.72	0.82
	22	38	51	97	1000	6.14	230	4.22	nil	4.22	1.88		0.24
	23 /												

* 950 ml Blood transfused ≡ 26.56

blood lost contained ≡ 15.32

CASE No. 23. (Contd.)

DATE		INTAKE PROT.	FAT	CARB.	CALS.	TOTAL N IN	OUTPUT URINE VOL.	URINE N	STOOL N	TOTAL N OUT	BALANCE +	-	URINE CL. (as g NaCl)
May	23	55	66	152	1422	8.8	810	lost	0.82				0.07?
	24	70	71	166	1584	11.2	980	11.6	nil	11.6		0.4	3.0
	25	70	86	185	1794	11.2	750	10.1	nil	10.1	1.1		3.02
	26	89	94	185	1942	14.22	470	5.74	nil	5.74	8.48		2.59
	27	66	80	151	1588	11.56	1220	18.1	nil	18.1		6.54	7.72
	28	49	78	194	1674	7.84	610	9.15	1.54	10.69		2.85	3.6
	29	64	83	198	1715	10.24	810	11.82	nil	11.82		1.58	4.8
	30	52	75	198	1675	8.42	1600	9.50	1.9	11.4		2.98	4.36
	31	64	83	198	1795	10.24	1490	15.42	nil	7.71	2.53		11.71
June	1	64	83	186	1747	10.24			3.76	11.48		1.24	
	2	63	82	198	1782	10.08	650	6.79	nil	6.79	3.29		4.92
	3	63	82	198	1782	10.08	740	7.55	nil	7.55	2.53		5.71
	4	63	82	188	1742	10.08	720	8.2	nil	8.2	1.88		
	5	61	85	203	1821	9.7	590	6.2	nil	6.2	3.5		

CASE No. 24.

DATE	PROT.	FAT	CARB.	CALS.	NET N IN	URINE VOL.	URINE N	STOOL N	TOTAL N OUT	+	-	URINE CL (as NaCl)	URINE Amino Acid N.
	INTAKE					OUTPUT				BALANCE			
1947 Sept. 22	90	106	303	2500	14.40	1670	12.84	0.54	13.34	1.06			
23	90	106	303	2500	14.40	1460	12.90	1.07	13.97	0.43		10.66	0.42
24	90	106	303	2500	14.40	1560	11.91	0.6	12.51	1.89		10.59	0.26
25	90	106	303	2500	14.40	1300	13.4	1.66	15.06		0.66	-	0.47
26	90	106	303	2500	14.40	1630	14.85	0.16	15.01		0.61	10.26	0.41
27	90	106	303	2500	14.40	1400	14.28	0.96	15.24		0.84	8.96	0.36
28	90	106	303	2500	14.40	1700	14.43	nil	14.33	0.1		10.20	0.39
29	90	106	303	2500	14.40	1600	10.69	1.04	11.73	2.67		11.29	0.25
30	Operation	- nil -			nil	400	1.32	nil	1.32		1.32	1.07	-
Oct. 1	9	6	120	570	1.44	1130	16.32	nil	16.32		14.88	2.73	0.28
2	9	6	120	570	1.44	800	15.3	lost	15.3		13.86	1.22	0.26
3	9	6	120	570	1.44	700	13.5	nil	13.5		12.06	0.91	0.38
4	19	6	87	478	3.04	790	12.94	nil	12.94		9.9	1.14	0.21

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CASE No. 24. (Contd.)

DATE		PROT.	FAT	CARB	CALS.	NET N IN	URINE VOL.	URINE N	STOOL N	TOTAL N OUT	+	-	URINE CL (as NaCl)	URINE Amino Acid N.
						INTAKE		OUTPUT			BALANCE			
1947 Oct.	5	30	19	132	819	4.80	720	11.38	0.49	11.87		6.93	0.93	0.18
	6	40	24	131	900	6.40	900	11.94	nil	11.94		5.54	1.08	0.20
	7	60	50	263	1502	9.60	1095	13.68	3.77	17.45		7.85	2.60	0.21
	8	90	106	303	2500	14.40	1790	17.4	nil	17.4		3.0	9.42	0.35
	9	90	106	303	2500	14.40	1320	13.28	2.58	15.86		1.46	9.75	0.32
	10	85	106	303	2480	13.60	1860	16.72	1.09	17.81		4.21	12.7	0.32
	11	90	106	303	2500	14.40	1000	9.56	nil	9.56	4.84		7.44	0.20
	12	89	101	296	2433	14.24	1400	13.25	4.58	17.83		3.59	8.54	0.28
	13	90	106	303	2500	14.40	1240	11.8	1.06	12.86	1.94		6.9	0.24
	14	Operation.			Died.									

CASE No. 25. Height: 5 ft. 7 ins.

DATE		INTAKE					OUTPUT			N BALANCE					
DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.	URINE CL. (as NaCl)
1947 Apr.	17	91	114	288	2542	14.56	1100	11.31	0.91	12.22	2.34		140.75		10.38
	18	91	114	288	2542	14.56	740	8.40	0.33	8.73	5.83		140.12		16.42
	19	91	109	288	2497	14.56	2320	20.26	1.50	10.37	4.19		139.8		16.0
	20	91	114	288	2542	14.56				10.37	4.19				
	21	91	114	288	2542	14.56	785	13.53	nil	13.53	1.03		140.0		8.41
	22	91	114	288	2542	14.56	790	13.48	nil	13.48	1.08		140.25		7.54
	23	91	114	288	2542	14.56	1350	12.07	1.05	13.12	2.44		140.0		10.4
	24	91	114	288	2542	14.56	880	10.46	lost	10.46	4.10				7.94
	25	91	114	288	2542	14.56	405?	6.55	nil	6.55			140.0		
		Operation													
	26	3	2	89	386	0.48	790	19.90	nil	9.95		9.47		99.0	1.14
	27	6	2	91	406	0.96				9.95		8.99		99.2	
	28	11	7	89	463	1.76	400	9.50	nil	9.50		7.74		99.0	0.35
	29	/													

CASE NO. 25.(Contd.)

		INTAKE					OUTPUT				N BALANCE				
DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.	URINE CL. (as NaCl)
1947 Apr.	29	35	33	158	1069	5.60	390	8.15	1.78	9.83		4.23			0.34
	30	52	64	220	1612	8.22	615	8.12	0.48	8.60		0.38			4.67
May	1	59	66	233	1762	9.44	680	7.94	nil	7.94	1.50				6.46
	2	61	60	221	1668	9.76	1070	11.20	0.84	12.04		2.28	134.25		9.18
	3	72	73	209	1781	11.52	1160	7.20	nil	7.20	5.32				9.28
	4	77	74	206	1798	12.32	1350	11.12	1.92	13.54		1.22	134.25		10.50
	5	89	111	275	2455	14.22	1230	12.73	lost	12.73	1.49		134.0		9.18
	6	91	114	288	2542	14.56	925	11.64	0.46	12.1	2.46		134.1		6.36

CASE No. 26.

	INTAKE						OUTPUT				BALANCE			
DATE	PRONUTRIN g	PROT.	FAT	CARB	CALS.	N	URINE VOL.	URINE N	STOOL N	N LOSS	+	−	BODY WT. in LBS.	URINE CL.
Feb. 22		97	120	300	2668	15.50	1990	12.64	1.9	14.54	0.96		151.5	
23		96	105	300	2529	15.40	2110	14.77	nil	14.77	0.63		151.6	
24		96	105	310	2569	15.40	1660	7.30	nil	7.30	8.10		147.75	
25		96	105	300	2529	15.40	1245	12.55	3.69	16.24		0.84	147.18	
26	160	96	105	300	3169	34.60	2540	22.95	0.44	23.39	11.20		147.75	
27	160	96	105	300	3169	34.60	2130	21.75	0.75	22.50	12.10		148.12	
28	160	118	114	322	3426	38.10	2900	28.30	3.47	31.77	6.33		150.5	
Mar. 1	160	118	114	322	3426	38.10	2690	31.90	nil	31.90	6.20		148.87	
2	160	118	114	322	3426	38.10	2790	30.60	nil	30.60	7.50		150.75	
3	160	118	114	322	3426	38.10	2500	28.00	1.62	29.62	8.48		151.00	
4	160	118	114	322	3426	38.10	3100	29.55	nil	29.55	8.55		150.75	
5	130	118	114	322	3305	34.50	3180	29.70	3.48	33.18	1.32		153.12	15.50
6	160	118	114	322	3425	38.10	2910	28.95	nil	28.95	9.15		151.50	12.42
7*		165	14	55	1006	26.40	1810	24.05	lost				149.50	9.30
8 /														

* Day of imaginery operation: intake to represent equivalent of blood transfusion.

CASE No. 26. (Contd.)

			INTAKE				OUTPUT				BALANCE			
DATE	PRONU-TRINg	PROT.	FAT	CARB	CALS.	N	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. in LBS.	URINE CL.
Mar. 8		3	nil	124	508	0.48	2130	17.70	nil	17.7		17.22		5.65
9		3	nil	124	508	0.48	910	9.72	1.56	11.28		10.80	148.0	2.22
10		8	10	16	186	1.28	920	11.08	nil	11.08		9.80	145.12	2.87
11		22	21	76	581	3.52	700	10.58	0.74	11.32		7.80		1.18
12		70	67	158	1635	11.02	1150	13.42	1.13	14.55		3.53	142.25	2.76
13		80	81	231	1973	12.80	1740	8.47	nil	8.47	5.33		143.37	7.80
14		81	86	236	2042	12.95	1246	10.17	3.56	13.73		0.78	141.6	
15		80	84	236	2020	12.80	1410	10.50	nil	10.50	2.30		142.0	lost
16		80	84	236	2020	12.80	1420	9.66	1.32	10.98	1.82		142.5	
17		96	105	300	2529	15.36	1450	9.22	nil	9.22	6.14		144.5	15.90
18		96	105	300	2529	15.36	1790	11.34	1.96	13.30	2.06		146.25	17.25
19		94	105	287	2469	15.04	1600	12.45	2.29	14.74	0.30		145.25	22.50
20		96	105	300	2529	15.36	1880	11.23	nil	11.23	4.13			15.20

CASE No. 27.

Height: 5 ft. 8 ins.

	INTAKE					OUTPUT				BALANCE				
Date.	Prot.	Fat	CHO	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	N. loss	+	-	Body wt. in lbs.	Urine Chloride (as NaCl)	Urine Amino N.
1947.														
Aug. 30.	90	91	332	2502	14.56	1050)	20.84)	Nil	10.42	4.14			7.95	0.61
31.	90	91	332	2502	14.56	)	)	2.18	12.60	1.96			7.95	0.61
Sept. 1.	90	91	332	2502	14.56	1050	12.98	2.22	15.20		0.64		9.32	0.62
2.	90	91	332	2502	14.56	1375	15.88	1.20	17.08		2.52		12.35	0.97
3.	90	91	332	2502	14.56	2140	13.00	1.04	14.04	0.52			12.20	0.67
4.	10	4	126	580	1.6	2100	10.26	Nil	10.26		8.66	120.2	9.80	0.11
5.	10	4	126	580	1.6	685	8.38	Nil	8.38		6.78	119.4	3.24	0.42
6.	10	4	126	580	1.6	980	6.92	Nil	6.92		5.32	118.2	2.84	0.43
7.	20	4	116	580	3.2	1200	11.75	Nil	11.75		8.55	116.6	3.38	0.54
8.	30	13	142	805	4.8	1320	10.70	Nil	10.70		5.90	115.8	3.09	0.67
9.	40	25	130	905	6.4	1320	10.55	Nil	10.55		4.15	116.0	3.32	0.59
10.	60	49	206	1505	9.6	1430	13.85	3.02	16.87		7.27	117.25	5.00	0.40
11.	90	91	332	2502	14.56	1890	12.90	0.78	13.68	0.88		117.9	9.97	0.42
12.	90	91	332	2502	14.56	2050	14.53	Nil	14.53	0.03		118.3	13.30	0.65
13.	90	91	332	2502	14.56	2490	15.66	1.54	17.20		2.64	118.5	14.22	0.68
14.	90	91	332	2502	14.56	1870	15.35	0.66	16.01		1.45	118.8	14.04	0.43
15.	90	91	332	2502	14.56	1240	10.07	0.56	10.63	3.93		118.9	8.04	0.56
16.	90	91	332	2502	14.56	1850	14.87	1.06	15.93		1.37	119.0	13.13	0.37
17.	90	91	332	2502	14.56	2910	17.69	0.74	18.33		3.77	118.5	16.00	0.67
18.	90	91	332	2502	14.56	1210	13.79	1.34	15.13		0.57		9.36	0.53

CASE No. 28a

Height: 5 ft. 8½ ins.

	INTAKE					OUTPUT				BALANCE				
Date.	Prot.	Fat	CHO	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	N. loss	+	-	Body wt. in lbs.	Urine Cl. (as NaCl)	Urine Amino Acid N.
1947. Aug. 29.	91	90	332	2502	14.56	1230	18.61	Nil	18.61		4.05		12.70	0.90
30.	91	90	332	2502	14.56	2920)	27.3)	Nil	13.65	0.91			12.50	0.46
31.	91	90	332	2502	14.56	)	)	2.02	15.67		1.11		15.20	0.46
Sept. 1.	91	90	332	2502	14.56	1200	14.30	Nil	14.30	0.26			10.92	Lost
2.	91	90	332	2502	14.56	980	16.70	2.19	18.89		4.36		15.50	0.31
3.	91	90	332	2502	14.56	2295	15.08	Nil	15.08		0.52		14.52	0.30
4.	10	4	126	580	1.6	1070	8.12	Nil	8.12		6.52	158.0	4.10	0.14
5.	10	4	126	580	1.6	650	9.40	Nil	9.40		7.80	154.75	3.44	0.45
6.	10	4	126	580	1.6	1110	12.40	Nil	12.40		10.80	153.5	4.06	0.65
7.	20	4	126	580	2.4	1350	10.00	2.58	12.58		9.38	155.5	5.80	0.58
8.	30	13	142	805	4.8	1960	12.83	3.08	15.91		11.11	156.3	8.90	0.75
9.	40	25	130	905	6.4	1270	11.42	Nil	11.42		5.02	156.6	5.53	0.34
10.	60	49	206	1505	9.6	1565	12.30	Nil	12.30		2.70	156.4	8.55	0.47
11.	91	90	332	2502	14.56	1390	13.18	Nil	13.18	1.38		156.6	9.58	0.69
12.	91	90	332	2502	14.56	1330	10.38	Nil	10.38	3.12		157.0	6.76	0.47
13.	91	90	332	2502	14.56	2180	17.00	3.78	20.78		6.22	156.0	17.40	0.93
14.	73	76	332	2304	11.66	1300	13.26	Nil	13.26		1.60		10.00	-
15.	91	90	332	2502	14.56	880	9.68	2.18	11.86	2.70			7.35	0.26
16.	91	90	332	2502	14.56	1620	14.45	Nil	14.45	0.11		154.5	11.60	0.54
17.	91	90	332	2502	14.56	1350	10.96	2.69	13.65	1.09		155.2	10.78	0.30
18.	91	90	332	2502	14.56	1620	18.04	Nil	18.04		3.43		8.80	0.82

CASE No. 28 ([illegible])

Height: 5 ft. $8\frac{1}{2}$ ins.

	INTAKE					OUTPUT				BALANCE.		
Date. 1947.	Prot.	Fat.	CHO.	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	N Loss.	+	-	Body wt. in lbs.
Mar. 14.	90	91	331	2503	14.40	2460	21.23	Nil	21.23		6.83	
15.	90	91	331	2503	14.40	2090	17.83	Nil	17.83		3.43	
16.	90	91	331	2503	14.40	2625	18.80	Nil	18.80		4.40	169.3
17.	90	91	331	2503	14.40	1370	10.34	3.78	14.12	0.28		167.8
18.	90	99	320	2531	14.40	1460	16.47	Nil	16.47		2.07	167.75
19.	10	29	550	2501	1.60	2340	11.55	Nil	11.55		9.95	165.1
20.	10	29	550	2501	1.60	2520	8.39	Nil	8.39		6.79	165.3
21.	10	29	550	2501	1.60	1120	5.07	Nil	5.07		3.47	165.4
22.	20	45	504	2501	3.20	1120	5.39	4.56	9.95		6.75	165.7
23.	30	56	469	2500	4.80	1590	5.92	0.86	6.78		1.98	165.75
24.	40	93	376	2501	6.40	1050	7.68	Nil	7.68		1.28	164.2
25.	60	92	358	2500	9.60	1160	9.28	0.80	10.08		0.48	163.6
26.	90	93	326	2501	14.40	1740	10.85	Nil	10.85	3.55		163.8
27.	90	93	326	2501	14.40	1460	11.25	Nil	11.25	3.15		164.12
28.	90	93	326	2501	14.40	1130	14.40	2.20	16.40		2.0	164.3
29.	90	93	326	2501	14.40	1960		Nil				164.25
30.	90	93	326	2501	14.40	2060	12.61	2.02	14.63		0.23	164.3
31.	90	93	326	2501	14.40	1730	16.88	Nil	16.88		2.48	163.8
April 1.	90	93	326	2501	14.40	2415	13.52	2.08	15.60		1.20	163.2

Date	Urinary Chloride (as NaCl)	SODIUM. Intake	SODIUM. Urine	SODIUM. Balance +	SODIUM. Balance -	CHLORIDE. Intake	CHLORIDE. Urine	CHLORIDE. Balance +	CHLORIDE. Balance -
1948 March 14	11.58	3.93	4.98		1.05	6.11	7.04		0.93
15	12.05	3.84	5.42		1.58	6.02	7.34		1.32
16	13.75	3.89	5.30		1.41	6.16	8.36		2.20
17	9.24	3.81	3.16	0.65		5.95	5.62	0.37	
18	11.36	4.02	4.07		0.05	6.42	6.90		0.48
19	11.68	4.01	4.28		0.27	6.08	7.10		1.02
20	8.15	3.22	3.06	0.16		4.90	4.96		0.06
21	6.31	4.01	2.10	1.91		6.08	3.84	2.24	
22	6.22	3.44	1.90	1.54		5.28	3.78	1.50	
23	8.08	3.98	2.82	1.16		6.07	4.92	1.15	
24	10.79	3.92	4.48		0.56	6.07	6.56		0.49
25	9.04	1.80	3.78		1.98	2.47	5.50		3.03
26	9.33	3.84	3.88		0.04	6.07	5.68	0.39	
27	10.01	3.75	3.92		0.17	6.07	6.08		0.01
28	10.50	3.92	4.26		0.34	6.21	6.39		0.18
29	13.29	4.25	5.15		0.90	6.69	8.05		1.36
30	11.11	4.28	4.47		0.19	6.69	6.74		0.05
31	10.18	4.02	3.81	0.21		6.40	6.18	0.22	
April 1	11.19	3.72	4.05		0.33	6.08	6.77		0.69

Height 6 ft. 1 in.

CASE No. 29A.

DATE	Intake				Output					Balance		Body wt. in lb.	Urine Cl. (As NaCl)	Urine Amino Acid N
	Prot.	Fat.	Carb.	Cals.	Total N	Urine Vol.	Urine N	Stool N	N Loss	+	−			
Aug.29	91	90	332	2502	14.56	[illegible]740	12.10	nil	12.10	2.46			9.26	0.53
30	91	90	332	2502	14.56	2740	29.40	nil	14.70		0.14		8.72	0.75
31	91	90	332	2502	14.56			1.58	16.28		1.72		8.72	0.75
Sept.1	91	90	332	2502	14.56	1630	14.48	nil	14.48	0.08			9.90	lost
2	91	90	332	2502	14.56	1040	15.32	2.31	17.63		3.07		10.50	0.78
3	91	90	332	2502	14.56	1230	15.08	nil	15.08		0.52		9.80	0.82
4	10	4	126	580	1.6	2230	12.90	nil	12.90		11.30	149.2	12.20	0.36
5	10	4	126	580	1.6	635	9.45	nil	9.45		7.85	148.2	4.48	0.66
6	10	4	126	580	1.6	960	10.72	nil	10.72		9.12	147.8	4.26	0.53
7	20	4	116	580	3.2	1360	9.75	4.74	14.49		11.29	147.6	6.16	0.44
8	30	13	142	805	4.8	650	15.51	nil	10.51		5.71	147.3	4.22	0.49
9	40	25	130	905	6.4	1510	12.01	nil	12.01		5.61	147.3	7.60	0.59
10	60	49	206	1505	9.6	1350	14.10	nil	14.10		4.50	147.5	13.10	0.57
11	91	90	332	2502	14.56	1350	12.20	nil	12.20	2.36		147.8	11.70	0.84
12	91	90	332	2502	14.56	2020	14.93	3.52	18.45		3.89	148.1	12.72	0.76
13	78	85	331	2401	12.48	1550	17.42	nil	17.42		4.94	148.5	13.96	1.12
14	91	90	332	2502	14.56	685	6.32	2.06	8.38	6.18			6.95	0.23
15	91	90	332	2502	14.56	1930	14.59	nil	14.59		0.03		14.70	1.16
16	91	90	332	2502	14.56	1400	13.25	1.73	14.98		0.42	149.1	10.94	0.50
17	91	90	332	2502	14.56	1710	11.49	nil	11.49	3.07		150.1	11.12	0.61
18	91	90	332	2502	14.56	1810	16.22	1.48	17.70		3.14		13.22	1.07

CASE No. 29B. Height 6 ft. 1 in.

DATE		Intake					Output				N Balance		
		Prot.	Fat	Carb.	Cals.	Total N	Urine vol.	Urine N	Stool N	N Loss	+	-	Body wt. in lb.
1948 March	14	90	91	331	2503	14.40	940	9.40	nil	9.40	5.0		
	15	90	91	331	2503	14.4	1190	12.86	nil	12.86	1.54		
	16	90	91	331	2503	14.4	980	14.03	1.34	15.37		0.97	147.75
	17	90	91	331	2503	14.4	1935	14.78	nil	14.78		0.38	148.5
	18	90	99	320	2531	14.4	2020	14.72	nil	14.72		0.32	148
	19	10	29	550	2501	1.6	980	9.86	nil	9.86		8.26	148.5
	20	10	29	550	2501	1.6	1590	8.41	1.00	9.41		7.81	148
	21	10	29	550	2501	1.6	1300	7.65	nil	7.65		6.05	149.5
	22	20	45	504	2501	3.2	970	6.27	2.16	8.43		5.23	148
	23	30	56	430	2344	4.8	1200	5.80	nil	5.80		1.00	147.5
	24	40	93	376	2501	6.4	900	7.14	nil	7.14		0.74	147.5
	25	60	92	358	2500	9.6	840	7.50	1.16	8.66	0.94		147.5
	26	90	93	326	2501	14.4	1365	11.10	nil	11.10	3.30		147
	27	90	93	326	2501	14.4	1260	12.10	2.36	14.47		0.07	146.75
	28	90	93	326	2501	14.4	890	13.29	nil	13.29	1.11		147.75
	29	90	93	326	2501	14.4	905	14.80	nil	14.80		0.40	145.5
	30	90	93	326	2501	14.4	1245	14.00	nil	14.00	0.40		145.25
	31	90	93	326	2501	14.4	790	10.49	1.78	12.27	2.13		146
Apr.	1	90	93	326	2501	14.4	1900	10.11	nil	10.11	4.29		145.5

CASE No. 29B.

DATE	Urinary Chloride (as NaCl.)	Sodium Intake	Sodium Urine	Sodium Balance +	Sodium Balance -	Chloride Intake	Chloride Urine	Chloride Balance +	Chloride Balance -
1948									
March 14	6.02	3.75	2.48	1.27		5.81	3.65	2.15	
15	9.43	3.43	3.52		0.09	5.38	5.72		0.34
16	6.79	3.69	2.63	1.06		5.84	4.12	1.72	
17	11.62	3.50	4.82		1.32	5.46	7.05		1.59
18	11.40	3.86	4.32		0.46	6.16	6.92		0.76
19	6.64	3.16	2.37	0.79		4.75	4.03	0.72	
20	4.83	2.12	1.64	0.48		3.19	2.93	0.26	
21	6.70	2.50	2.10	0.40		3.74	4.06		0.32
22	5.48	2.16	1.81	0.35		3.31	3.33		0.02
23	5.06	1.82	2.08		0.26	2.78	3.07		0.29
24	8.64	3.05	3.79		0.74	4.73	5.23		0.50
25	7.13	2.26	2.98		0.72	3.17	4.32		1.15
26	12.40	3.86	5.33		1.47	6.07	7.53		1.46
27	12.01	3.76	4.40		0.64	6.07	7.28		1.21
28	9.07	3.66	4.17		0.51	5.80	5.50	0.30	
29	9.12	?	3.81			5.53	5.53		
30	11.95	3.84	4.24		0.40	6.00	7.25		1.25
31	8.40	3.89	3.88	0.01		6.19	5.11	1.08	
April 1	8.26	3.72	2.76	0.96		6.07	5.02	1.05	

CASE No. 30.

Height: 5 ft. 9 ins.

Date.	INTAKE Prot.	Fat.	CHO.	Cals.	Total N.	OUTPUT Urine Vol.	Urine N.	Stool N.	N Loss.	N. Balance +	-	Body wt. in lbs
1948. Mar. 14.	90	91	331	2503	14.40	2110	18.74	Nil	18.74		4.34	
15.	90	91	331	2503	14.40	1025	13.21	2.42	15.63		1.23	
16.	90	91	331	2503	14.40	1395	16.10	Nil	16.10		1.70	150.6
17.	90	91	331	2503	14.40	2080	14.56	1.86	16.42		2.02	151.2
18.	90	99	320	2531	14.40	2210	14.73	Nil	14.73		0.33	150.7
19.	10	29	550	2501	1.60	1660	9.15	Nil	9.15		7.45	150.2
20.	10	29	550	2501	1.60	2360	9.34	1.20	10.54		8.94	-
21.	10	29	550	2501	1.60	1390	8.02	Nil	8.02		6.42	151.1
22.	20	45	504	2501	3.20	1000	6.76	1.32	8.08		4.88	152.6
23.	30	56	469	2500	4.80	1925	8.16	Nil	8.16		3.36	151.6
24.	40	93	376	2501	6.40	1015	6.70	1.18	7.88		1.48	150.2
25.	60	90	358	2500	9.60	920	7.95	0.72	8.67	0.93		149.6
26.	90	93	326	2501	14.40	1520	12.50	Nil	12.50	1.90		152.5
27.	90	93	326	2501	14.40	2510	12.55	0.70	13.25	1.15		151.5
28.	90	93	326	2501	14.40	1350	11.35	Nil	11.35	3.05		150.8
29.	90	93	326	2501	14.40	1490	13.96	1.61	15.57		1.17	151.12
30.	90	93	326	2501	14.40	1490	15.40	0.82	16.22		1.82	148.9
31.	90	93	326	2501	14.40	2805	15.15	1.18	16.33		1.93	149.6
Apr. 1.	90	93	326	2501	14.40	1280	13.12	Nil	13.12	1.28		148.9

CASE No. 30.

	URINARY.	SODIUM.				CHLORIDE.			
Date.	Chloride (As NaCI)	Intake.	Urine.	Balance. +	Balance. -	Intake.	Urine.	Balance. +	Balance. -
1948. March 14.	11.45	3.61	5.21		1.60	5.63	6.94		1.31
15.	10.10	3.80	4.11		0.31	6.00	6.13		0.13
16.	8.25	3.89	3.49	0.40		6.15	5.00	1.15	
17.	9.56	3.81	3.25	0.56		5.94	5.80	0.14	
18.	10.35	4.03	3.88	0.15		6.41	6.27	0.14	
19.	8.06	4.02	3.01	1.01		6.08	4.89	1.19	
20.	8.25	4.00	3.30	0.70		6.08	5.00	1.08	
21.	8.37	2.97	3.01		0.04	4.46	5.07		0.61
22.	7.20	3.94	2.53	1.41		5.98	4.37	1.61	
23.	9.44	2.79	3.67		0.88	4.21	5.72		1.51
24.	9.54	3.31	4.02		0.71	5.12	5.78		0.66
25.	7.84	3.73	2.99	0.74		5.43	4.75	0.68	
26.	11.04	3.85	4.19		0.34	6.06	6.70		0.64
27.	14.75	3.63	5.83		2.20	5.87	8.94		3.07
28.	9.64	3.93	3.72	0.21		6.20	5.84	0.36	
29.	13.85	3.87	5.50		1.63	6.10	8.40		2.30
30.	11.17	4.26	4.25	0.01		6.64	6.76		0.12
31.	15.15	4.62	6.08		1.46	6.69	9.19		2.50
April 1.	8.42	3.73	3.38	0.35		6.06	5.11	0.95	

CASE No. 31.

DATE		INTAKE						OUTPUT				N BALANCE				
DATE		PROT.	PRO-NUTRIN	FAT	CARB	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT.	TEMP °F.
1946 Oct.	5	119	-	160	258	2848	19.04	2100	16.30	2.42		18.72	0.32		138.1	
	6	119	-	160	258	2848	19.04	1450	13.60	1.02		14.62	4.32			
	7	119	-	160	258	2848	19.04	1830	16.40	2.26		18.66	0.38			
	8	113	-	160	258	2824	18.08	1980	14.80	1.00		15.80	2.28			
	9	119	-	160	258	2848	19.04	1580	12.32	0.73		13.05	5.99			
	10	119	-	160	258	2848	19.04	1560	15.70	0.73		16.43	2.61			
	11	93	-	138	243	2586	14.88	1020	10.80	2.06		12.86	2.02			
	12	84	-	119	251	2411	13.44	1610	10.70	1.53		12.23	1.21			
	13	112	-	166	273	3034	17.92	1680	17.55	1.22		18.77		0.75		
	14	109	-	157	261	2893	17.44	1910	12.15	1.03		13.18	4.26			
	15	119	-	154	273	2954	19.04	890	9.40	1.05		10.45	8.59		139	
	16	119	-	154	273	2954	19.04	1500	14.28	1.05		15.78	3.26			
	17	192	-	147	273	2823	16.32	2100	8.40	3.64		12.04	4.28			
	18	/														

CASE No. 31. (Contd.)

DATE	INTAKE						OUTPUT					N BALANCE			
	PROT.	PRO-NUTIN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT.	TEMP °F
1946															
Oct. 18	119	-	154	273	2954	19.04	1220	10.03	1.04		11.07	7.97		140.5	
19	119	-	154	273	2954	19.04	2120	14.06	2.12		16.18	2.86			
20	119	-	154	273	2954	19.04	2110	14.50	1.38		15.88	3.16			
21	80	-	125	229	2954	12.80	2400	8.65	lost						
22	Operation*			36	144		130	0.60	nil	3.28	16.53				101
23				96	384	nil	950	9.34	nil	3.08	12.42		12.42		100
24	144		17	73	501	2.30	820	13.90	nil	3.15	17.05		12.75		99.8
25	20		19	74	547	3.20	1010	22.46	nil		22.46		18.26		99.4
26	24		24	75	611	3.84	740	16.04	2.54		18.58		14.74		99
27	44		44	119	1048	6.23	1220	12.70	nil		12.70		6.47		
28	45		60	104	1136	5.82	1490	10.43	nil		10.43		4.61		
29 /															

*N content of 1000 ml Blood and 400 ml plasma not estimated.
Blood lost contained 11.79 gms. N.
Stomach resected contained 4.3 gms. N.

The N intake figures apply to food actually consumed, whereas the other intake figures refer to food given to the patient.

CASE No. 31.(Contd.)

DATE		INTAKE						OUTPUT					N BALANCE			
DATE		PROT.	PRO-NUTIN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT.	TEMP °F.
1946																
Oct.	29	93		80	183	1849	13.38	1480	10.30	nil		10.30	3.08			
	30	83		80	198	1865	10.16	1500	10.59	1.74		12.34		2.18		
	31	82	160	83	198	2507	31.06	1860	18.69	1.56		20.25	11.82			
Nov.	1	82	160	83	198	2507	30.08	2470	23.15	1.38		24.53	5.55		131.6	
	2	99	160	113	259	3059	34.38	2060	24.98	1.25		26.23	8.15			
	3	99	160	113	288	3205	32.04	2150	25.65	1.15		26.80	5.24			
	4	99	140	113	288	3125	33.80	1810	18.95	0.96		19.91	12.73		131.6	
	5	99		113	288	2565	15.65	2310	16.91	1.08		17.99		2.34		
	6	99		113	288	2565	14.71	1700	11.05	lost		11.05				
	7	63		109	288	2385	9.59	1330	11.30	1.72		13.02		3.43		
	8	99		113	288	2565	15.16	1990	14.60	1.72		16.32		1.16		
	9	99		113	288	2565	11.48	1380	9.05	2.03		22.34	1.20			
	10	99		113	288	2565	13.24	1710	11.26				1.20		130.6	
	11	99		113	288	2565	15.34	1640	9.68	0.90		10.58	4.78			

CASE No. 32. Height: 5 ft. 7 ins.

		INTAKE						OUTPUT					N BALANCE		
DATE		PROT.	PRO-NUTRIN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.
Nov.	1	119	-	109	322	2745	19.04	1065	12.9	2.71	-	15.61	3.43		151.6
	2	129	-	104	309	2684	20.18	1540	16.58	nil	-	16.58	3.6		
	3	128	-	103	292	2604	17.62	1650	16.0	0.45	2.52	18.97		1.35	
	4	126	-	103	285	2571	18.86	1150	12.22	1.26	3.42	16.90	1.86		153.9
	5	126	160	103	275	3180	38.06	1450	20.58	0.76	2.78	24.12	13.94		
	6	129	160	104	309	3328	38.96	2300	25.7	nil	2.19	27.89	11.07		
	7	129	160	104	309	3328	38.72	1620	18.65	1.00	1.98	21.63	17.00		
	8	129	160	104	309	3328	37.14	2800	21.76	nil	1.51	22.27	14.87		
	9	129	160	104	309	3328	72.6	1590	22.9	nil	lost	22.9 +	13.4		
	10	129	160	104	309	3328		2060	27.2	3.2	lost	30.4 +	5.9		154.3
	11	101	160	78	279	2862	35.36	1340	18.09	2.9	2.9	23.04	12.28		
	12	Operation*						1270	15.18	nil	0.61	15.79		15.79	
	13	/													

* Operation: 1974 ml. blood transfused contained 41.78 g.N.
blood lost " 32.4 g.N.
stomach resected " 3.31 g.N.

N intake figures refer to food consumed by patient.

CASE No. 32.(Contd.)

	INTAKE						OUTPUT					N BALANCE		
DATE	PROT.	PRO-NUTRIN	FAT	CARB.	CALS	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT in LBS.
Nov. 13	21		13	31.5	327	3.36	1770	27.5	nil	1.21	28.71		25.51	
14	21		13	31.5	327	3.36	660	12.48	nil	0.28	12.76		9.40	
15	19		12	29	301	3.1	1080	25.06	4.3	-	29.36		26.26	
16	41		7	81	551	6.55	1020	25.04	nil	-	25.04		18.49	
17	47		34	108	926	7.52	350	8.28	5.52	-	13.8		6.28	
18	97		37	213	1573	15.2	785	16.02	nil	-	16.02		0.82	
19	93		58	187	1642	11.56	640	11.95	0.5	-	12.45		0.89	
20	102		95	237	2211	14.93	770	12.35	3.36	-	15.71		0.78	
21	106		94	278	2382	12.96	1060	14.82	nil	-	14.52		1.56	
22	101		101	282	2473	10.96	990	14.61	0.96	-	15.57		4.59	
23	109		101	282	2473	13.17	620	10.47	1.48	-	11.95	1.22		
24	109		101	282	2473	13.81	1010	13.72	nil	-	13.72	0.09		140.0
25	109		101	282	2473	13.66	620	9.45	2.7	-	12.15	1.51		

CASE No. 33.

Height: 5 ft. $3\frac{1}{2}$ ins.

	INTAKE						OUTPUT					N BALANCE		
DATE	PROT.	PN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N OUT	+	-	BODY WT. in LBS.
Nov. 1	126	-	110	305	2713	20.16	680	8.8	2.25	-	11.05	9.11		103.2
2	126	-	102	296	2605	20.16	1220	15.12	nil	-	15.12	5.04		
3	126	-	102	296	2605	19.90	1300	15.01	0.62	-	15.63	4.27		
4	126	-	102	317	2690	20.16	1050	15.58	3.66	-	19.24	0.82		
5	126	160	102	317	3330	39.36	1720	23.2	1.4	-	24.6	14.76		105.4
6	126	160	102	317	3330	37.52	2130	23.85	0.7	-	24.55	12.97		
7	126	160	102	317	3330	39.19	1900	22.12	2.7	-	24.82	14.37		
8	126	160	102	317	3330	39.26	1930	24.0	2.1	-	26.1	13.16		
9	126	160	102	317	3330	39.36	2050	29.9	nil	-	29.9	9.46		
10	126	160	102	317	3330	39.36	1800	25.2	2.69	-	27.89	11.47		105.2
11	126	160	102	317	3330	39.36	2260	26.58	nil	-	26.58	12.78		
12	126	160	102	317	3330	39.36	2010	23.2	2.92	-	26.12	13.24		
13	126	160	102	317	3330	39.36	2580	24.55	2.18	0.57	27.2	12.12		

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CASE No. 33. (Contd.)

DATE	INTAKE						OUTPUT					N BALANCE		
	PROT.	PN	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N.	STOOL N.	SUCTION N.	N OUT	+	-	BODY WT. in LBS.
Nov. 14	Operation*						1230	10.38		1.56	11.94		11.94	
15	19.35		12	29	301	3.10	570	9.68	-	4.06	13.74		10.64	
16	42		26	63	654	6.72	180	3.22	1.0	3.81	8.03		1.31	
17	42		26	110	842	6.72	1030	24.25	0.5	0.37	25.12		18.4	
18	56		7	110	731	8.96	640	16.83	nil	-	16.83		7.87	
19	74		54	151	1386	11.82	730	15.95	nil	-	15.95		4.13	
20	82		54	152	1426	13.10	735	12.18	3.1	-	15.28		2.18	
21	99		97	294	2450	15.04	915	12.88	2.02	-	14.9	0.14		
22	97	120	97	284	2877	27.39	1290	15.88	1.38	-	17.26	10.13		
23	97	85	97	284	2737	23.90	1160	18.15	1.64	-	19.79	4.11		
24	97	-	97	284	2397	15.09	1240	15.04	1.78	-	16.82		1.73	
25	97	-	97	284	2397	14.80	1115	13.42	2.02	-	15.44		0.64	

*Operation: N content of 1480 ml blood transfused = 40.06 g. N.
lost blood = 24.0 g. N.
resected stomach = 4.12 g. N.

N intake figures refer to food consumed by patient.

CASE No. 34.

Height 5 ft. 9 ins.

DATE		PROT.	PN	FAT	CARB.	CALS.	NET N2 INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	N_2 BALANCE +	N_2 BALANCE -	BODY WT. in LBS.
Nov.	27	137	160	98	328	3382	41.16	1840	26.03	2.2	-	28.23	12.93		159.0
	28	137	160	98	328	3382	41.16	1845	28.1	2.55	-	30.65	10.51		
	29	137	160	98	328	3382	41.16	2570	35.58	0.64	-	36.22	4.94		
	30	137	160	98	328	3382	41.16	1780	31.65	2.5	-	34.15	7.01		
Dec.	1	137	160	98	328	3382	41.16	2090	29.16	nil	-	29.16	12.0		
	2	137	160	98	328	3382	41.16	1130	15.68	2.68	0.64	19.0	22.16		157.7
	3	Operation*	63		150	852	7.56	800	11.14	-	5.12	16.26		8.70	
	4	47		34	149	1092	7.52	750	17.75	-	1.76	19.54		12.02	
	5	40		24	127	994	6.4	890	21.05	lost	4.98	26.03		19.63	
	6	28		33	49	812	3.52	1220	16.75	-	0.56	17.31		13.79	
	7	28		33	49	605	4.48	1300	18.0	1.44	-	19.44		14.96	
	8 /														

* 990 ml of transfused blood ≡ 21.31 grs. N.
blood lost ≡ 18.6 grs. N.
Stomach resected contained 4.0 grs. N.

CASE No. **34.**(Contd.)

DATE		PROT.	PN	FAT	CARB	CALS.	NET N_2 INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	N_2 BALANCE +	N_2 BALANCE -	BODY WT. in LBS.
		INTAKE					OUTPUT								
Dec.	8	17		20	32	376	2.72	1760	18.08	1.08	-	19.16		16.44	
	9	78		67	202	1723	12.5	1250	15.5	1.04	-	16.54		4.04	
	10	90		75	209	1871	14.4	2020	16.64	lost	-	16.64		2.24	
	11	94		75	209	1887	15.0	1780	14.23	nil	-	14.23	0.77		
	12	116		95	276	2425	18.35	1110	15.2	2.1	-	17.3	1.05		
	13	128		68	305	2344	19.84	1300	16.7	-	-	16.7	3.14		
	14	128		108	305	2705	20.44	2220	18.94	1.89	-	20.83		0.39	
	15	127		105	313	2705	20.32	1420	13.01	nil	nil	13.01	7.31		
	16	127		105	313	2705	20.32	1470	15.7	nil	nil	15.7	4.62		147.0
	17	127		105	313	2705	20.32	1360	15.2	2.53	nil	17.73	2.59		
	18	127		105	313	2705	20.02	1500	14.55	1.94	nil	16.49	3.53		
	19	127		105	313	2705	20.32	990	9.52	nil	nil	9.53	10.79		153.0

CASE No. 35. Height: 5 ft. $8\frac{1}{2}$ ins.

DATE	INTAKE						OUTPUT					N BALANCE		
DATE	PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	TOTAL N LOSS	+	-	BODY WT. in LBS.
Nov. 29	137	160	98	328	3382	41.16	1650	27.8	2.06	-	29.86	11.3		151.7
30	137	160	98	328	3382	41.16	1820	32.85	3.6	-	36.45	4.71		
Dec. 1	137	160	98	328	3382	41.16	1630	27.05	1.0	-	28.05	13.11		
2	137	160	98	328	3382	41.16	910	16.16	1.48	-	17.64	23.52		150.5
3	137	160	98	328	3382	41.16	1560	26.05	1.93	-	27.98	13.18		
4	137	160	98	328	3382	41.16	1820	24.43	1.43	0.83	26.69	14.47		151.5
5	Operation*	100		305	1620	12.	630	8.68		8.23	16.91		4.91	
6		100		246	1384	12	1270	19.88		7.8	27.68		15.68	
7	26		14	61	474	4.16	930	24.0		4.76	28.76		24.6	
8	32		18	218	1162	5.12	1130	24.25	0.82	4.6	29.67		24.55	
9				126	504	nil	795	14.98	3.1	0.64	18.72		18.72	
10				120	480	nil	1490	22.12	1.6		23.72		23.72	
11 /														

* 930 ml. of transfused blood ≡ 24.33 gr. N.
lost blood ≡ 14.2 gr. N.
stomach resected contained 3.35 gr. N.

CASE No. 35. (Contd.)

	INTAKE						OUTPUT					N BALANCE		
DATE	PROT.	PN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	TOTAL N LOSS	+	-	BODY WT. in LBS.
Dec. 11					nil	nil	1430	18.9	lost		18.9		18.9	
12	32	-	40	64	742	5.12	1660	17.0	1.3	nil	18.3		13.18	
13	80	-	70	189	1706	12.8	1680	17.92	1.39	nil	19.31		6.51	
14	80	-	70	189	1706	12.8	2300	18.23	2.6	-	20.83		8.03	
15	80	-	70	189	1706	12.8	2280	15.19	4.95	-	20.14		7.34	
16	87	-	74	226	1918	13.92	2340	14.12	3.02	-	17.14		3.22	
17	87	-	74	226	1918	13.92	1880	13.68	1.68	-	15.36		1.44	142.25
18	87	-	74	226	1918	13.50	1680	8.7	1.56	-	10.26	3.24		
19	87	-	74	226	1918	13.92	1420	13.4	3.12	-	16.52		2.6	142.0

CASE NO. 36 Height 5 ft. $4\frac{3}{4}$ ins.

	INTAKE						OUTPUT					N. BALANCE				
Date	Vol. of Casydrol. ml.	Prot.	Fat.	Carb.	Cals.	Total N Intake	Urine Vol.	Urine N.	Stool N.	Suction N	Total N Loss	+	−	Body wt in lbs.	Temp °F	Urine Cl. as NaCl.
April 26		114	114	319	2758	18.24	1700)	22.5)	1.72)		12.11	6.13		116.8		19. 25)
27		114	114	319	2758	18.24	)	)	)		12.11	6.13		117.25		)
28		114	114	319	2758	18.24	620	7.69	1.17		8.86	9.38		118.75		7.63
29		114	114	311	2726	18.24	690	11.58	nil		11.58	6.66		118.75		4.93
30		114	114	319	2758	18.24	710	9.80	1.84		11.64	6.60		117.4		6.54
May																
1	OPERATION X	nil	nil	48	192	nil.	660	12.86	nil	nil	12.86		12.86	117.1	101	1.74
2	1970	81	nil	98	716	12.96	650	14.11	0.46	0.08	14.65		1.69		100	0.96
3	730	60	35	126	1059	9.60	1210	32.60	nil	nil	32.60		23.0		100.4	0.73
4	2430	106	10	174	1210	16.96	720	21.20	0.12	1.56	22.88		5.92	108.2	99.6	0.32
5	2700	130	22	170	1398	20.80	1440	38.20	0.24	0.20	38.64		17.84		100	0.37
6	2430	116	18	153	1238	18.54	1260	28.40	0.72		29.12		10.58		101	0.78
7		13	19	40	383	2.08	1270	20.57	1.44		22.01		19.93		99.6	4.19
8		39	39	118	979	6.25	1330	18.52	0.21		18.73		12.48			10.44
9		62	75	170	1603	9.92	1400	14.21	2.10		16.31		6.39	117.75		9.06
10		65	81	162	1637	10.40	2090	14.92	2.32		17.24		6.84	116.5	99.2	13.00
11		69	79	232	1915	11.04	1290	13.00	nil		13.00		1.96	114.5		8.55
	OPERATION ‡															
12		66	76	234	1884	10.56	1380	15.51	2.08		17.59		7.03	112.6	101	7.13
13		70	86	233	1986	11.20	1290	15.80	0.84		16.64		5.44	111.0		6.71
14		68	83	244	1995	10.88	1020	14.74	1.50		16.24		5.36	110.75		6.52
15		68	83	244	1995	10.88	1280	10.62	1.28		11.90		1.02	110.75		7.07
16		68	83	244	1995	10.88	1730	14.26	0.53		14.79		3.91	110.37		9.95
17		68	83	244	1995	10.88	1700	13.40	3.00		16.40		5.52	109.88		10.03
18		97	94	317	2502	15.52	1910	12.80	0.78		13.58	1.94		109.75		11.25
19		97	94	317	2502	15.52	2180	11.25	nil		11.25	4.27		110.5		12.30
20		97	94	317	2502	15.52	1840	14.50	1.94		16.44		0.92	109.63		8.04
21		97	94	317	2502	15.52	1770	11.86	nil		11.86	3.66		110.75		7.20
22		97	94	317	2502	15.52	810	8.55	2.45		11.00	4.52		110.7		12.28
23		103	102	352	2738	16.48	1670	13.58	2.62		16.20	0.28		109.9		9.25
24		103	102	352	2738	16.48	1300	13.90	nil		13.90	2.58				10.83
25		103	102	352	2738	16.48	1610	14.38	3.60		17.98		1.50			11.72
26		103	102	352	2738	16.48	1590	12.92	0.92		13.84	2.64				

X Operation 1. Gastrectomy.
970 ml. blood transfused = 27.79 g.N
blood lost = 18.51 g.N
Stomach resected contained = 2.70 g.N

‡ Operation 2. Incision and drainage of abscess of leg.

	INTAKE				URINE		
	Vol. of Casydrol: Ml.	Total N.	Amino Acid N.	Peptide N.	Total N.	Amino Acid N.	Peptide N.
May 1	2 pints of blood				12.86	.33	
2	1970	12.96	6.50	3.15	14.11	1.46	1.82
3	730	4.80	2.41	1.17	32.60	3.47	4.21
4	2430	15.98	8.03	3.89	21.20	1.69	2.34
5	2700	17.75	8.93	4.33	38.20	3.36	3.20
6	2430	15.98	8.03	3.89	28.40	3.15	4.29
7					20.57	1.67	2.55
8					18.52	3.40	
9					14.21	1.96	
10					14.92	4.08	
11					13.00	2.09	
12					15.51	2.48	

3

CHLORIDE BALANCE (as NaCI).

	INTAKE.			OUTPUT.			Balance.	
Date	.9% Saline	Casydrol	Total.	Urine	Suction	Total	+	-
May 1	7.20	970 ml. blood.		1.74	-	1.74		
2	3.60	5.92	9.52	0.96	.06	1.02	8.50	
3	3.60	2.19	5.79	0.73	-	0.73	5.06	
4	3.24	7.29	10.53	0.32	3.02	3.34	7.19	
5	3.78	8.10	11.88	0.38	0.52	0.92	10.96	
6	7.20	7.29	14.49	0.78	-	0.78	13.71	

CASE NO. 37.

Height 5ft 9 ins.

	INTAKE						OUTPUT					N.BALANCE				
Date	Vol.of Casydrol ml.	Prot.	Fat	Carbo-Hydrate	Cals.	Total N. Intake	Urine Vol.	Urine N.	Stool N.	Suct: ion N.	Total N.Loss	+	-	Body wt.in lbs.	Temp. °F.	Urine Cl. as NaCl.
May 12		109	120	288	2668	17.44	2280	18.53	0.26		18.79		1.35	129.75		13.40
13		107	120	278	2620	17.12.	2040	9.30	2.18		11.48	5.64		128.75		8.53
14		81	105	240	2229	12.96	740	12.10	2.36		14.46		1.50	127.25		2.88
OPERATION																
15 X		Nil	Nil	28 ?	112	Nil	660	11.10	Nil	0.35	11.45			127.25	100	2.11
16	2700	111	Nil	135	984	17.75	840	14.70	Nil	1.40	16.10	1.65			98.8	0.94
17	3880	156	Nil	187	1372	24.82	2250	41.80	Nil	2.66	44.46		19.64		99.9	0.34
18	2160	93	5	118	889	14.88	1570	28.80	Nil	0.13	28.93		14.05		101	0.06
19	2580	126	14	193	1402	20.18	1600	26.60	2.74		29.34		9.16		103	0.56
20		42	48	124	1096	6.72	1340	20.02	1.69		21.71		14.99	128.8	99	1.93
21		46	50	130	1154	7.35	1850	23.55	NIL		23.55		16.20	127.5	98.9	7.33
22		65	74	182	1654	10.40	1220	16.00	1.78		17.78		7.38			6.22
23		65	74	182	1654	10.40	2050	17.55	Nil		17.55		7.15	124.8		9.40
24		65	74	182	1654	10.40	2380	15.62	Nil		15.62		5.22			8.24
25		65	75	170	1615	10.40	2240	17.30	2.20		19.50		9.10			8.87
26		84	90	218	2018	13.43	1770	11.80	Nil		11.80	1.63		121.5		5.27
27		86	96	240	2168	13.76	1750	16.44	3.72		20.16		6.40			8.82
28		86	96	240	2168	13.76	1860	13.20	Nil		13.20	0.56				9.25
29		86	96	240	2168	13.76	2150	13.33	2.24		15.57		1.81			
30		86	96	240	2168	13.76	2080	14.56	1.42		15.98		2.22	120.12		

X 495 Ml blood transfused = 19.18 g. N.
blood lost contained = 10.7 g. N.
stomach resected contained = 3.68 g. N.

CASYDROL INFUSION (NITROGEN DISTRIBUTION)

Date.	INTAKE Vol. of Casydrol in ml.	Total N.	Amino Acid N.	Peptide N.	URINE Total N.	Amino Acid N.	Peptide N.
May 14.					12.10	1.48	0.89
15.	495 ccs. Blood				11.10	0.66	1.32
16.	2700	17.75	8.93	4.33	14.70	1.66	1.89
17.	3780	24.82	12.48	6.05	41.80	6.75	7.65
18.	2160	14.20	7.13	3.46	28.80	3.14	5.66
19.	2580	16.95	8.51	4.13	26.60	3.40	1.80
20.					20.02	1.13	1.09
21.					23.55	2.50	

CHLORIDE BALANCE (as NaCI)

Date.	INTAKE .9% Saline.	Casydrol.	Total.	OUTPUT Urine.	Suction.	Total.	BALANCE +	−
May 15.	10.8	+ 495 ccs. Blood		2.71	.66	3.37		
16.	-	8.10	8.10	0.94	5.0	5.94	2.16	
17.	3.6	11.34	14.94	0.34	8.95	9.29	5.65	
18.	3.6	6.48	10.08	0.06	0.75	0.81	9.27	
19.	Food .85	7.64	8.49	0.56	-	0.56	7.93	

CASE No. 38

Date	Vol. of Casydrol in ml.	INTAKE Prot.	Fat	Carb.	Cals.	TOTAL N.	OUTPUT Urine Vol.	Urine N.	Stool N.	Suction N.	Total N. Loss	N. BALANCE +	-	Body wt. in lbs.	Body Temp °F.	Urine Cl. as NaCl
July																
10		123	146	316	3070	19.70	1040	14.52	0.77		15.29	4.41				8.2
11		123	137	316	2989	19.70	1030	13.76	0.98		14.74	4.96		138.5		8.96
12		123	146	316	3070	19.70	1450	18.34	nil		18.34	1.36				10.97
13		123	146	316	3070	19.70	910	12.60	nil		12.60	7.10				7.56
14		123	146	316	3070	19.70	1660	5.94	1.97	0.73	8.64	11.06		140.25		1.0
OPERATION X																
15		2	24	3	42	.320	740	9.78	nil		9.78				100.8	5.62
16	2700	111	nil	135	984	17.75	1360	23.20	nil		23.20		5.45		100.0	5.94
17	2160	94	4	117	880	15.02	1420	24.20	nil		24.20		9.18		101.0	2.13
18	1620	75	8	97	760	12.00	2430	26.78	0.89		27.67		15.67		102.0	6.45
19	540	44	31	32	583	7.04	1430	16.19	1.89		18.08		11.04		103.6	2.12
20		16	20	45	424	2.56	1820	26.60	nil		26.60		24.04		101.0	0.49
21		70	53	209	1593	11.20	1750	25.15	nil		25.15		13.95	135.4	99.2	2.62
22		57	64	213	1656	9.13	1610	18.20	1.70		19.90		10.77		99.4	5.02
23		72	61	215	1697	11.52	1820	18.74	nil		18.74		7.22	133.5	99.2	11.04
24		74	74	226	1866	11.84	2150	16.50	nil		16.50		4.66			12.40
25		81	84	250	2080	12.96	1180	10.74	1.50		12.24	0.72		129.3		6.64
26		109	112	267	2512	17.44	1680	20.00	nil		20.00		2.56			11.02
27		109	112	267	2512	17.44	1360	19.26	2.03		21.29		3.85	126.		1.40
28		109	112	257	2472	17.44	1190	16.66	nil		16.66	0.78				5.66
29		110	118	267	2570	17.60	1260	16.07	3.80		19.87		2.27			6.40
30		107	113	266	2509	17.12	1150	14.43	nil		14.43	2.69		128.0		6.48

X 490 Ml. blood transfused = 15. 28 g.N

blood lost contained 8. 68 g.N

stomach resected contained = 4. 38 g.N

CASYDROL INFUSION (NITROGEN DISTRIBUTION)

	INTAKE.				URINE.			
Date.	Vol. of Casydrol in ml.	Total N.	Amino Acid N.	Peptide N.	Total N.	Urea N.	Amino Acid N.	Peptide N.
July 10.					14.53		0.54	0.62
11.					13.76		0.40	1.86
12.					18.34	15.65	0.15	-
13.					12.60	9.54	0.52	1.82
14.					5.94	4.38	1.53	.09
15.					9.78	7.75	0.41	2.47
16.	2700	17.75	8.93	4.22	23.20	16.50	1.62	3.80
17.	2160	14.20	7.14	3.46	24.20	17.40	1.69	4.10
18.	1620	10.65	5.35	2.59	26.78	18.30	3.50	2.15
19.	540	3.55	1.78	0.87	16.19	11.72	1.40	-
20.					26.60	22.36	0.84	1.58
21.					25.15	21.80	1.15	0.52
22.					18.20	15.28	1.32	-
23.					18.74	15.30	1.44	1.00
24.					16.50	14.00	0.93	-
25.					10.74	9.15	0.66	0.61
26.					20.00	16.62	0.94	1.66
27.					19.26	14.66	0.62	

3.

CHLORIDE BALANCE (as NaCI)

	INTAKE				OUTPUT	BALANCE	
	Food.	.9% Saline.	Casydrol.	Total.	Urine.	+	-
July 15.		10.80	- 490 ml blood.		5.62		
16.	-	7.20	8.10	15.30	5.94	9.36	
17.	0.25	3.60	6.48	10.33	2.13	8.20	
18.	0.57	7.20	4.80	12.57	6.45	6.12	
19.	1.11		1.62	2.73		0.51	

CASE NO. 39. Height 5 ft. 8".

	INTAKE.						OUTPUT.					BALANCE				
Date	Casydrol Vol. in ml.	Prot.	Fat	Carbo-hydrate	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	Suct: ion N.	N. Loss	+	-	Body wt. in lbs.	Body temp °F.	Urine Cl. as NaCl.
July.10		114	98	299	2534	1822	1870	15.78	NIL		15.78	2.44				7.96
11		114	89	299	2453	18.22	840	12.18	1.05		13.23	4.99		120.25		5.75
12		114	98	299	2534	18.22	910	10.62	3.00		13.62	4.60				5.11
13		114	98	299	2534	18.22	1100	15.85	NIL		15.85	2.37		121.0		6.91
14		114	98	299	2534	18.22	910	12.93	0.65		13.58	4.64				6.59
15		114	98	299	2534	18.22	1450	14.08	NIL		14.08	4.14				8.32
16		114	98	299	2534	18.22	1900	8.55	1.23	0.09	9.87	8.35				4.82
OPERATION X																
17		NIL	NIL	NIL	NIL	NIL	240	2.19	NIL	0.96	3.15			117.25		0.81
18	2620	108	NIL	131	1048	17.20	1920	25.00	NIL	lost	25.00		7.80		100.2	6.14
19	2700	111	NIL	135	1080	17.75	1580	22.49	NIL	1.39	23.88		6.13		101.2	2.46
20	2160	99	12	138	1056	15.80	2160	35.65	NIL	0.53	36.18		20.38		100.8	0.82
21	2700	130	28	170	1352	20.79	2270	34.00	0.69	NIL	34.69		13.90	120.0	101.6	1.13
22	540	36	17	46	481	5.79	1860	25.20	0.40	NIL	25.60		19.81		99.0	1.34
23		46	47	145	1187	7.36	2150	21.55	0.22		21.77		14.41	120.5		1.93
24		74	75	198	1763	11.82	2350	19.80	1.65		21.45		9.63			4.37
25		71	75	235	1899	11.36	2120	17.70	0.69		18.39		7.03	119.25		10.34
26		114	116	264	2556	18.22	2440	19.70	NIL		19.70		1.48			12.40
27		114	116	264	2556	18.22	2440	18.80	3.15		21.95		3.73	115.8		10.00
28		114	116	264	2556	18.22	1940	19.30	NIL		19.30		1.08			7.64
29		110	118	267	2570	17.60	1920	17.80	0.76		18.56		0.96	115.25		6.37
30		110	118	267	2570	17.60	1640	17.33	0.57		17.90		0.30	114.5		6.40

X 460 ml. blood transfused = 11.0 g. N.
blood lost contained 15.0 g. N.
stomach resected contained 3.03 g. N.

CASE No. 39.

CASYDROL INFUSION (NITROGEN DISTRIBUTION)

	INTAKE				URINE			
	Vol. of Casydrol in ml.	Total N.	Amino Acid N.	Peptide N.	Total N.	Urea N.	Amino Acid N.	Peptide N.
July 10.					15.78		1.40	0.81
11.					12.18		1.18	0.23
12.					10.62		1.30	1.40
13.					15.85		1.52	0.87
14.					12.93	9.15	1.67	0.22
15.					14.08	11.50	0.86	0.47
16.					8.55	6.75	1.98	-
17.					2.19	1.80	0.36	0.12
18.	2620	17.20	8.65	4.19	25.00	15.08	3.02	1.51
19.	2700	17.75	8.93	4.22	22.49	13.74	3.30)	
20.	2160	14.20	7.54	3.46	33.65	22.35	4.23)	Not
21.	2700	17.75	8.93	4.22	34.00	23.72	5.95)	estimated
22.	540	3.55	1.78	0.87	25.20	18.10	4.62)	
23.					21.55	18.58	1.68	1.16
24.					19.80	15.17	2.75	1.53
25.					17.70	13.06	1.12	-
26.					19.70	15.03	2.07	-
27.					18.80	16.99	1.76	-

CHLORIDE BALANCE (as NaCI)

INTAKE			OUTPUT			BALANCE	
.9% Saline.	Casydrol.	Total.	Urine.	Suction.	Total.	+	-
10.8	460 ccs. Blood.		0.81	0.68	1.49	10	
7.2	7.86	15.06	6.14	Lost			
3.6	8.10	11.70	2.46	7.44	9.90	1.80	
-	6.48	6.48	0.82	4.74	5.56	0.92	
-	8.10	8.10	1.14	-	1.14	6.96	
-	1.62	1.62	1.34	-	1.34	0.28	

CASE NO. 40.

	INTAKE						OUTPUT					N.BALANCE			
Date	Vol. of Amigen ml.	Prot.	Fat	Carbo-Hydrate	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	Suction N.	N. Loss	+	-	Body wt. in lbs.	Max. temp. F.
1949															
Feb. 21		91	101	330	2593	14.56	1280	11.12	0.88	1.33	13.33	1.23		136	
22		75	92	295	2308	12.00	1780	9.98	Nil		9.98	2.02		134	
23		91	101	330	2593	14.56	720	10.62	Nil	0.32	10.94	3.62		134	
24		92	104	343	2676	14.72	760	9.98	2.12	3.19	15.29		0.57	133.5	
25	OPERATION		X	40	160		500	5.66	Nil	3.24	8.90				100
26	1830	74	Nil	103	708	11.92	350	5.38	Nil	0.61	5.99	5.93			101.4
27	1780	72	Nil	89	644	11.60	1210	30.54	Nil	1.34	31.88		20.28		101.8
28	1940	101	25	169	1305	16.17	920	23.50	Nil	0.32	23.82		7.65		100.8
Mar. 1	869	79	53	144	1369	12.64	930	21.56	Nil		21.56		8.92	130.75	99.6
2		57	65	121	1297	9.12	720	16.92	Lost					130.5	101.0
3		79	87	160	1739	12.64	980	19.05	Nil		19.05		6.41	129.4	100.5
4		90	96	222	2112	14.40	650	10.72	2.04		12.76	1.64		132.4	99.2
5		94	106	268	2402	15.04	1220	20.30	1.06		21.36		6.32	131.0	
6		94	106	268	2402	15.04	1430	13.62	Nil		13.62	1.42			
7		93	105	258	2349	14.88	1030	10.80	0.94		11.74	3.14		129.5	
8		79	104	237	2200	12.64	600	10.00	1.42		11.42	1.22		125.9	
9		83	114	267	2426	13.28	920	9.26	Nil		9.26	4.02		126.5	

X 480 c.c. blood transfused = 16.7 g N.
blood lost contained 3.80 g. N.
stomach resected contained = 2.48 g. N.

CASE No. 40.

AMIGEN INFUSION (NITROGEN DISTRIBUTION)

Date.	INTAKE. Vol. of Amigen.	Total N.	Amino Acid N.	Peptide N.	URINE. Total N.	Urea N.	Amino Acid N.	Peptide N.
Feb. 21.					11.12.	9.18.	0.22	0.54
22.					9.98	8.52	0.22	0.57
23.					10.62	8.11	0.13	0.55
24.					9.98	8.28	0.20	0.44
25.	OPERATION				5.66	4.47	0.14	0.28
26.	1830	11.92	7.69	2.56	5.38	4.66	0.18	0.36
27.	1780	11.60	7.47	2.49	30.54	25.38	1.36	2.03
28.	1940	12.65	8.14	2.72	23.50	21.25	0.96	1.72
Mar. 1.	870	5.67	3.65	1.22	21.56	18.88	0.85	1.87
2.					16.92	13.98	0.24	1.16
3.					19.05	16.95	0.34	0.87
4.					10.72	7.77	0.31	0.49
5.					20.30	15.98	0.50	1.02
6.					13.62	11.08	0.47	0.73
7.					10.80	8.05	0.27	0.74
8.					10.00	7.48	0.24	0.57
9.					9.26	7.62	0.20	0.38

CASE NO. 40.

		SODIUM							CHLORIDE						
Date.	Urinary Chloride as NaCl	Total intake	Urine	Stool	Suction	Total loss	Balance +	Balance -	Total intake	Urine	Stool	Suction	Total loss	Balance. +	Balance. -
1949.															
Feb. 21.	6.77	2.62	3.34	-	0.35				4.07	4.10	0.06	3.08	7.24		3.17
22.	4.14	2.41	2.29	Nil	Nil	2.29	0.12		3.70	2.51	-	-	2.51	1.19	
23.	2.84	3.20	1.93	Nil	0.12	2.05	1.15		5.01	1.72	-	1.23	2.95	2.06	
24.	2.71	2.55	2.20	0.71	0.65	3.56		1.01	3.86	1.64	0.07	2.75	4.46		0.60
25.	OPERATION														
	1.61	3.33	0.70	Nil	1.27	1.97	1.36		4.83	0.98	-	1.90	2.85	1.95	
26.	1.74	2.01	0.66	Nil	0.86	1.52	0.49		2.23	1.06	-	1.74	2.80		0.57
27.	1.86	2.42	0.66	Nil	1.73	2.39	0.03		2.88	1.13	-	3.92	5.05		2.17
28.	0.18	2.18	0.59	Nil	0.37	0.96	1.22		2.52	0.01	-	1.12	1.13	1.39	
Mar. 1.	0.35	1.75	0.98	Nil		0.98	0.77		2.45	0.21			0.21	2.24	
2.	0.78	2.79	0.25	Lost					4.42	0.48	Lost		0.48	3.94	
3.	0.98	3.20	1.03	Nil		1.03	2.17		5.11	0.60	-		0.60	4.51	
4.	2.21	3.68	1.57	0.37		1.94	1.74		5.88	1.34	0.09		1.43	4.45	
5.	6.58	2.58	3.32	0.10		3.42		0.84	4.24	3.99	0.12		4.11	0.13	
6.	8.72	1.97	3.92	Nil		3.92		1.95	3.32	5.29	-		5.29		1.97
7.	6.67	2.03	2.74	0.21		2.95		0.92	3.46	4.04	0.06		4.10		0.64
8.	3.90	1.75	1.41	.08		1.49	0.26		2.77	2.36	0.08		2.44	0.33	
9.	4.71	1.95	1.70	Nil		1.70	0.25		3.12	2.86	-		2.86	0.26	

CASE NO. 41. Height 5 ft. 10½ ins.

		INTAKE.					OUTPUT					N. BALANCE				
Date	Vol.of plasma in ml.	Prot.	Fat	Carbo-hydrate	Cals.	Total N. Intake	Urine Vol.	Urine N.	Stool N.	Suc:tion N.	Total N. Loss	+	-	Body wt. in lbs.	Temp. °F.	Urine Cl. as NaCl.
1948																
Oct.17		87	94	256	2218	13.92	1280	13.08	0.18		13.26	0.66		152.5		7.09
18		90	95	255	2235	14.40	1640	11.81	Nil		11.81	2.59				6.20
19		90	97	256	2257	14.40	1530	9.46	0.71		10.17	4.23		152.5		7.45
20		90	97	256	2257	14.40	1570	12.71	Nil		12.71	1.69				8.04
21		90	97	256	2257	14.40	1340	14.50	Nil		14.50	0.10		152.6		
22		90	97	256	2257	14.40	1410	9.90	0.79	1.42	12.31	2.09		152.6		6.55
OPERATION X																
23				80	320		970	8.73		2.73	11.46			152.5	100.4	5.52
24	1555	44.4		60		7.10	1340	15.08		0.92	16.00		8.90		100.4	6.60
25	400	10.3		60		1.66	1150	20.30			20.30		18.64		100.8	4.46
26	800	14.2		60		2.27	1320	23.50		0.08	23.50		21.23	157.75	103.0	5.80
27	1774	56.25		20		9.01	lost								103.2	lost
28	1670	62.6		Nil		10.26	77	0.55			0.55	9.71			103.4	0.49
29				40	160		Nil								105.8	

Died 9.20 p.m.

X Operation 420 ml blood transfused = 10.84 g. N.
Blood lost contained = 9.9 g.N.
Stomach resected contained = 2.49 g. N.

CASE NO.42

		INTAKE					OUTPUT.					N.BALANCE					
Date	Vol.of Plasma in ml.	Prot.	Fat	Carbo-hydrate	Cals.	Total N.	Urine Vol.	Urine N.	Stool N	Suc: :tion N.	N. Loss	+	-	Body wt. in lbs.	Body Temp. oF.	Urine Amino Acid N.	Urine Chloride (as NaCl).
1947																	
Sept.22		90	100	310	2500	14.40	1270	10.67	0.45		11.12	3.28					
23		90	100	310	2500	14.40	1540	12.58	0.26		12.84	1.56				0.55	11.87
24		90	100	310	2500	14.40	1210	11.38	2.46		13.84	0.56				0.42	9.56
25		81	96	301	2392	12.96	1020	9.74	0.18		9.92	3.04				0.34	
26		90	100	310	2500	14.40	1820	13.48	0.74		14.22	0.18				0.45	10.30
27		90	100	310	2500	14.40	1390	11.21	0.53		11.74	2.66				0.46	9.58
28		90	100	310	2500	14.40	1980	14.03	Nil		14.03	0.37				0.45	12.68
29		90	100	310	2500	14.40	2110	14.95	1.19		16.14		1.74			0.57	13.75
30		90	100	310	2500	14.40	1000	8.74	0.34		9.08	5.32				0.16	8.28
Oct. 1		51	78	274	2002	8.16	2300	11.24	2.06		13.30		5.14	121		0.26	9.58
2	OPERATION X						300	3.67	Nil	2.04	5.71				100	0.11	0.87
3	770					6.10	1100	16.83	Nil	0.28	17.11		11.01		100	0.23	4.88
4	935					6.98	1100	13.70	Nil		13.70		6.72		100.4	0.22	3.41
5						Nil	790	12.94	Nil		12.94		12.94		101	0.14	2.15
6		44	48	138	1160	7.04	560	10.90	1.09		11.99		4.95			0.30	1.62
7		65	58	148	1374	10.40	1060	18.35	Nil		18.35		7.95			0.64	2.44
8		70	68	189	1648	11.20	1790	17.40	1.76		19.16		7.96	119		0.31	3.04
9		73	79	260	1648	11.66	1000	17.80	Nil		17.80		6.14			0.35	9.75
10		95	90	206	2014	15.18	1630	17.92	lost							0.31	8.81
11		90	93	219	2076	14.40	1450	14.55	Nil		14.55		0.15	118.8		0.19	12.75
12		91	90	238	2126	14.56	2000	14.56	1.21		15.77		1.21			0.47	11.20
13		91	100	262	2312	14.56	1725	10.49	2.24		18.73		4.17			0.17	10.28
14		90	97	265	2294	14.40	1550	12.22	Nil		12.22	2.18		116.7		0.15	9.63
15		90	97	256	2257	14.40	2280	16.44	1.79		18.23		3.83			0.31	11.54
16		90	87	256	2167	14.40	2000	15.56	Nil		15.56		1.16			0.30	10.76
17		90	97	256	2257	14.40	1750	14.30	0.57		14.87		0.47	115.3			9.0

450 ml.Blood transfused = 9.48 g.N.
Blood lost contained = 2.32 g.N.
Stomach resected contained =3.12 g. N.

SE No. 43.

TE	DIET	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. IN LBS.	URINE CL as NaCl
	INTAKE						OUTPUT			N BALANCE				
947														
t. 12				40	160	nil	1890	8.48	nil	8.48		8.48		12.08
13				80	320	nil	1915	5.83	1.29	7.12		7.12		5.11
14	Operation			40	160	nil	375	1.87	nil	1.87		1.87		3.29
15	A	87	37	260	1721	13.92	965	9.34	nil	9.34	4.58			6.86
16		119	46	374	2386	19.04	1680	17.90	2.49	20.39		1.35		21.60
17		119	46	374	2386	19.04	1730	15.60	0.33	16.13	2.91			24.60
18		119	46	374	2386	19.04	4360	25.00	3.14	14.07	4.43		116.5	26.70
19		119	46	374	2386	19.04				14.07	4.43			26.70
20		119	46	374	2386	19.04	2050	13.58	nil	13.58	5.46			34.70
21		119	46	374	2386	19.04	1950	18.12	3.09	21.21		2.17		34.80
22		119	46	374	2386	19.04	1335	14.13	0.93	15.06	3.98			22.40

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CASE No. 43 (Contd.)

		INTAKE					OUTPUT			N BALANCE				
DATE	DIET	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. IN LBS.	URINE CL as NaCl
Oct. 23		119	46	374	2386	19.04	1500	16.92	1.57	18.49	0.55			22.50
24		119	46	374	2386	19.04	1750	17.55	nil	17.55	1.49		117.5	18.32
25		119	46	374	2386	19.04	2400	15.94	1.60	16.74	2.30			16.32
26	B	119	46	374	2386	19.04	1705	14.75		15.55	3.49			13.30
27		119	46	374	2386	19.04	1300	13.88	1.23	15.11	3.93			9.0
28		119	46	374	2386	19.04	3100	19.95	2.48	22.43		3.39		18.74
29		119	46	374	2386	19.04	1435	14.30	2.22	16.52	2.42			14.15
30		119	46	374	2386	19.04	2020	15.15	1.63	16.78	2.26			10.50
31		119	46	374	2386	19.04	1420	15.27	nil	15.27	3.77			6.65
Nov. 1		119	46	374	2386	19.04	2940	25.20	7.68	16.44	2.60		116.75	10.69
2		119	46	374	2386	19.04				16.44	2.60			10.69
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CASE No. 43 (Contd.)

DATE	DIET	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	N BALANCE +	N BALANCE -	BODY WT. IN LBS.	URINE CL as NaCl
	INTAKE						OUTPUT							
Nov. 3		93	36	292	1864	14.88	510?	7.65	nil	7.65				4.91
4		119	46	374	2386	19.04	770	11.40	4.00	15.40	3.64			7.15
5		119	46	374	2386	19.04	1090	11.55	3.08	14.63	4.41			10.38
6		103	43	354	2215	16.48	1350	9.50	2.80	12.30	4.18			11.25
7		119	46	374	2386	19.04	1565	10.45	nil	10.45	8.59			10.48
8		119	46	374	2386	19.04	1610	15.15	7.45	18.87	0.17			11.65
9		119	46	374	2386	19.04	1060	7.90		11.62	8.42			8.01
10		119	46	374	2386	19.04	1400	8.40	1.18	9.58	9.46		114.4	10.60
11		119	46	374	2386	19.04	lost	11.50	1.98					lost
12		119	46	374	2386	19.04	2040	13.40	1.58	13.08	5.96			12.85
13		119	46	374	2386	19.04	1200	19.20	0.98	20.42	4.66			7.53
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CASE No. 43. (Contd.)

		INTAKE					OUTPUT				N BALANCE			
DATE	DIET	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. IN LBS.	URINE CL as NaCl
Nov. 14		119	46	374	2386	19.04	2700	19.20	1.22	20.42		1.38		12.04
15		53	20	166	1056	8.48	1100	14.47	nil	14.47		5.99		5.43
16		119	46	374	2386	19.04	920	10.45	nil	10.45	8.59		110.5	7.90
17		119	46	374	2386	19.04	2080	11.32	2.88	14.20	4.84			7.37
18	C	128	57	389	2581	20.48	2210	12.63	0.72	13.35	7.13			6.28
19		128	57	389	2581	20.48	2100	15.71	2.60	18.31	2.17			13.80
20		128	57	389	2581	20.48	1925	15.91	nil	15.91	4.57			11.42
21		128	57	389	2581	20.48	2210	17.55	2.14	19.69	0.79			12.06
22		128	57	389	2581	20.48	2130	17.71	2.02	19.73	0.75		114.25	15.15
23		128	57	389	2581	20.48	2760	13.38	1.88	15.26	4.22			12.59
24		128	57	389	2581	20.48	2980	16.35	3.32	19.67	0.81			12.05
	Partial oral feeding													
25		128	57	389	2581	20.48	3810	16.45	2.70	19.15	1.33			17.01
26		147	78	429	3006	23.58	2960	18.60	1.24	19.84	3.64			18.39
27		129	68	394	2704	20.62	3335	16.95	3.92	20.87		0.25		19.70
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CASE No. 43 (Contd.)

			INTAKE					OUTPUT			N BALANCE				
DATE		DIET	PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	N LOSS	+	-	BODY WT. IN LBS.	URINE CL as NaCl
Nov.	28	D	153	85	438	3129	24.52	2610	19.40	2.48	21.88	2.64			16.70
	29		147	79	422	2987	23.60	2645	17.38	1.50	18.88	4.72		118.25	19.40
	30		140	79	417	2939	22.40	1790	15.83	2.36	18.19	4.21			10.42
Dec.	1		123	64	357	2496	19.68	2350	19.40	2.04	21.44		1.76		14.62
	2		142	74	410	2894	22.72	2360	17.95	2.32	20.27	2.45			18.90
	3		144	78	414	2934	23.24	2380	18.40	0.88	19.28	3.96			21.25
	4		132	67	398	2723	21.12	2360	18.40	0.86	19.26	1.86			20.00
	5		149	84	428	3064	23.84	1880	18.06	1.06	19.12	4.72			12.40
	6		133	75	377	2715	21.28	2376	19.84	1.60	20.44	0.84			17.50
	7		150	82	427	3046	24.00	2300	19.62	2.50	20.12	3.88			14.70
	8		140	71	407	2827	22.40	1760	20.38	4.10	24.48		2.08		11.25
	9		146	83	417	2999	23.36	2470	17.30	3.20	20.5	2.86			18.45

DIET A = 1200 ml milk, 500 ml water, 240 grms. Dried Skimmed Milk, 200 grms. lactose and 20 grms. salt.
B = 1200 ml milk, 300 ml water, 240 grms. Dried Skimmed Milk, 200 grms. lactose and 10 grms. salt.
C = 1500 ml milk, 300 ml water, 240 grms. Dried Skimmed Milk, 200 grms. lactose and 10 grms. salt.
D = 1500 ml milk, 300 ml water, 240 grms. Dried Skimmed Milk, 200 grms. lactose. (Salt content of milk mixture = 6.39 grms.)

CASE No. 44.

	INTAKE					OUTPUT					N BALANCE		URINE	
Date.	Prot.	Fat	Carbo-hydrate	Cals.	N intake.	Urine Vol.	Urine N.	Stool N.	Suction N.	N Loss	+	-	Amino Acid N.	Chloride (as NaCI)
Oct. 14.	70	87	290	2215	11.20	880	8.43	Nil	1.39	9.82	1.38		0.14	0.91
15.	66	67	267	1935	10.56	615	5.92	0.19	1.80	7.91	2.65		0.10	1.85 (Suction 11.42)
16.	63	62	270	1890	10.08	500	4.88	Nil	4.23	9.01	1.07		0.10	0.79 (Suction 12.90)
17.	OPERATION Intrajejunal feeding commenced.													
	9	4	109	408	1.44	510	5.96	Nil	-	5.96			0.11	0.76
18.	71	28	248	1568	11.36)	1560	14.00	0.60	-	14.60		4.24	0.44	0.31
19.	40	15	145	875	6.40)		14.00	0.60	-	14.60		8.40	0.44	0.31
20.	60	23	187	1195	9.60	600	11.42	Nil	-	11.42		1.82	0.20	0.67
21.	119	46	374	2386	19.04	980	17.50	Nil	-	17.50	1.54		0.25	1.61
22.	119	46	374	2386	19.04	975	15.85	2.73	-	18.58	0.46		0.32	6.16
23.	84	69	188	1697	13.46	650	10.73	2.03		12.76	0.70		0.22	5.93
	Intrajejunal feeding stopped.													
24.	96	86	275	2258	15.36	990	15.88	1.38		16.74		1.38	0.32	9.50
25.	89	81	259	2121	14.24	1280	18.59	Nil		18.39		4.35	0.36	9.84
26.	93	90	290	2322	14.88	520 ?	6.63	1.66		8.29			0.18	
27.	94	81	258	2137	15.04	1120	9.40	0.94		10.34	5.30		0.22	6.80
28.	103	87	278	2308	16.48	1660	11.95	0.84		12.79	3.69		0.23	9.96
29.	100	100	329	2616	16.00	1295	9.74	1.29		11.30	4.70		0.34	8.65
30.	93	92	282	2328	14.88	1620	8.74	0.88		9.62	5.26		0.34	8.30
31.	92	84	248	2131	14.72	1460	9.40	Lost					0.26	8.60
Nov. 1.	93	85	255	2172	14.88	1455	10.14	Nil		10.14	4.74			

450 mls. Blood transfused = 11.65 g N.
Blood lost contained 6.02 g N.
Stomach resected contained 4.42 g N.

Case No. 44.

Chloride Balance (as NaCl.)

	Chloride Intake (g) Urine				
Date	0.9 saline	Milk mixt.	Total	Urine g.	Balance g.
Op.	14.44	2.02	16.42	0.76	
Oct.18	3.6	x15.6	19.20	0.32	+18.88
19	3.6	5.40	9.0	0.30	+8.70
20		5.47	5.47	0.67	+4.80
21		10.94	10.94	1.61	+9.33
22		10.94	10.94	6.16	+4.78

x 20 g. salt added to 1,800 ml. milk mixture on Oct. 18th; subsequently only 5 g./1800 ml. milk mixture.

CASE No. 45.

DATE.	Type of Feeding.	Intake					Output					Balance		Temp. in °F	Urine Chlor. (as NaCl)
		Prot.	Fat.	Carb.	Cals.	Total N. intake.	Urine Vol.	Urine N.	Stool N	Suction N.	N Loss	+	-		
1947															
Nov. 9	F	90	97	256	2257	14.40	750	6.34	0.44	0.39	7.17	7.23			2.8
10	F	75	96	265	2224	12.00	1570	7.96	nil	-	7.96	4.04			6.65
	OPERATION^x														
11	M.M.	90	35	280	1795	14.40	390	3.91	nil	-	3.91				2.51
12	M.M.	150	58	468	2994	24.00	605	12.08	nil	1.85	13.93	10.07		100	1.18
13	M.M.	119	46	374	2386	19.05	960	14.15	0.95	0.52	15.62	3.43			2.23
14	M.M.	90	35	280	1795	14.40	960	19.91	0.58	0.46	20.95		6.55	99.6	1.56
15	M.M.	90	35	280	1795	14.40	1000	22.08	2.42		24.50		10.10		4.10
16	M.M.& F.	107	67	326	2335	17.12	995	21.98	0.20		22.18		5.06		6.20
17	M.M.& F.	70	56	216	1648	11.20	1090	18.81	1.98		20.79		9.59		4.57
18	M.M.& F.	119	85	364	2697	19.05	1200	13.21	4.04		17.25	1.80			4.25
19	M.M.& F.	129	93	364	2809	20.60	1090	19.56	2.56		22.12		1.52		7.36
20	M.M.& F.	114	86	323	2522	18.25	1200	19.05	7.48		26.53		8.28		6.71
21	M.M.& F.	93	83	241	2083	14.88	1230	15.15	3.31		18.46		3.58	99.4	6.93
22	M.M.& F.	120	108	343	2824	19.20	680	10.34	6.18						3.62
23	M.M.& F.	134	113	395	3133	21.45	2100	20.22			23.33		1.88		9.32

Blood lost contained 4.88 gm.N.

Stomach resected contained 6.16 gm. N.

M.M. = milk mixture (for formula see text)

F. = ordinary food.

Case No. 45.

Chloride Balance (as Na Cl.)

	Intake (g)			Output (g)			Balance
Date.	0.9% saline	Milk Mixt.	Total	Urine	Suction	Total	g.
Op.	7.20	11.94	19.14	2.51		2.51	
Nov.12		19.88	19.88	1.18	1.03	2.26	+17.62
13		15.89	15.89	2.23	1.41	3.64	+12.25
14		11.94	11.94	1.56	1.69	3.25	+8.69
15		11.94	11.94	4.10		4.10	+7.84

CASE NO. 46

	INTAKE						OUTPUT					N.BALANCE				
Date	Type of Feeding	Prot.	Fat	Carbo-hydrate	Cals.	Total N.	Urine Vol.	Urine N	Stool N.	Suction N.	N. Loss	+	-	Temp °F.	Urine Chloride as NaCl	Suction Chloride as NaCl.
1947																
Nov.21	F.	91	101	256	2297	14.56	1025	11.77	NIL	0.17	12.94	1.62			3.86	0.81
22	F.	91	101	256	2297	14.56	1036	10.36	1.52	0.32	12.20	2.36			2.24	0.59
23	F.	91	101	256	2297	14.56	2000	12.88	NIL	0.35	13.23	1.33			1.80	0.44
24	F.						Lost									
	OPERATION															
25	M.M.	60	23	207	1275	9.60	360	5.03	NIL	1.42	6.45			102	1.44	0.88
26	M.M.	90	35	280	1795	14.40	505	7.68	3.06	0.71	11.45	2.95		101.4	1.74	
27	M.M.	90	35	280	1795	14.40	330	3.56	8.04	0.72	11.72	2.68		100	0.16	3.39
28	M.M.	90	35	280	1795	14.40	820	12.42	1.56		13.98	0.42			0.38	5.18
29	M.M.	90	35	280	1795	14.40	1340	28.05	3.25		31.30		16.90		0.35	
30	M.M.	90	35	280	1795	14.40	1420	32.20	4.24		36.44		22.04		0.86	
Dec. 1	M.M.&F.	128	74	389	2725	20.48	800	17.38	9.80		27.18		6.70		0.77	
2	F.	52	54	130	1214	8.32	1190	24.98	5.22		30.20		19.82		2.02	
3	F.	48	51	162	1299	7.68	665	12.22	1.28		14.50		6.82		1.95	
4	F.	62	64	189	1580	10.22	660	4.96	3.04		8.00	2.22			0.77	
5	F.	90	82	231	2026	14.40	lost		3.27							
6	F.	89	101	280	2385	14.26	1470	9.82	0.70		10.52	3.74			5.40	
7	F.	86	104	255	2300	13.78	1650	11.92	1.42		13.34	0.44			9.36	
8	F.	86	94	229	2106	13.78	1720	11.17	1.06		12.23	1.45			8.80	
9	F.	90	92	264	2244	14.40	1470	9.95	NIL		9.95	4.45			6.82	
10	F.	90	92	266	2252	14.40	1800	10.74	1.02		11.76	2.64			6.87	
11	F.	90	92	264	2244	14.40	1920	13.98	0.40		14.38	0.02			8.20	

M.M. = Milk Mixture
F. = Ordinary Food.

Case No. 46.

Chloride Balance (as NaCl).

Date.	Intake (g) 0.9% saline	Intake (g) Milk mixt.	Intake (g) Total	Output (g) Urine	Output (g) Suction	Output (g) Total	Balance g.
Op.	7.2	2.94	10.16	1.44	0.88	0.32	
Nov.26		4.44	4.44	1.74	3.39	5.13	-0.69
27		4.44	4.44	0.16	5.18	5.18	-0.90
28		4.44	4.44	0.38			+4.06
29		4.44	4.44	0.35			+4.07
30		4.44	4.44	0.86			+4.38
Dec. 1		4.90	4.14	0.77			+4.17

CASE No. 47.

		INTAKE					OUTPUT					N. BALANCE		URINE
Date.	Type of Feeding	Prot.	Fat	Carbo-hydrate	Cals.	Total N.	Urine Vol.	Urine N.	Stool N.	Suction N.	N. loss	+	-	Chloride (as NaCl)
1947.														
Nov. 27.	F	90	100	310	2500	14.40	640	9.76			10.60	3.8		4.88
28.	F	90	100	310	2500	14.40	645	10.28	0.84		10.28	4.12		5.36
29.	F	90	100	310	2500	14.40	870	11.22	Nil		12.52	1.88		7.25
30.	F	90	100	310	2500	14.40	875	10.07	1.30		12.53	1.87		7.55
Dec. 1.	F	90	100	310	2500	14.40	820	9.39	2.46		9.39	5.01		7.27
2.	F	90	100	310	2500	14.40	665	9.12	Nil		9.12	5.28		5.76
3.	F	90	100	310	2500	14.40	1250	11.71	Nil		11.71	2.69		6.20
4.	F	90	100	310	2500	14.40	1005	9.61	Nil		9.61	4.79		5.40
	OPERATION													
5.	M.M.	60	23	187	1195	9.60	110	0.48	Nil		0.48			0.57
6.	M.M.	90	35	340	2035	14.40	1310	17.70	nil		17.70		3.30	3.97
7.	M.M.	90	35	280	1795	14.40	990	21.0	Nil	2.74	23.74		9.34	2.73
8.	M.M.	90	31	280	1795	14.40	840	17.90	Nil		17.90		3.50	2.67
9.	M.M.	77	27	237	1535	12.30	540	10.86	Nil		10.86	1.44		2.03
10.	M.M.	70	70	218	1395	11.20	Lost		3.90					Lost
11.	M.M. & F.	90	71	254	1999	14.40	690	13.90	1.80		15.70		1.30	2.91
12.	F	90	92	238	1951	14.40	680	13.08	1.96		15.04		0.64	4.42
13.	F	90	92	264	2244	14.40	540	9.38	0.54		9.92	4.48		4.92
14.	F	90	92	264	2244	14.40	780	13.70	0.52		14.22	0.18		7.82
15.	F	90	92	264	2244	14.40	780	12.62	0.58		13.20	1.20		8.03
16.	F	90	92	264	2244	14.40	965	13.89	2.08		15.97		1.57	8.59
17.	F	90	92	264	2244	14.40	840	11.52	1.02		12.54	1.86		7.70

750 ml blood transfused = 19.87 g N.
Blood lost contained 19.5 g N.
Stomach resected contained 2.3 g N.

M.M. = Milk Mixture
F = Ordinary Food

Case No. 47.

Chloride Balance (as NaCl)

	Intake (g)			Output (g)			Balance
Date	0.9% Salt.	Milk Mixt.	Total	Urine	Suction	Total	g.
Op.	7.2	2.96	10.16	0.57		0.57	
Dec.6	7.2	4.44	11.64	3.97		3.97	+7.67
7		4.44	4.44	2.73	2.08	4.81	-0.41
8		4.44	4.44	2.67		2.67	+1.77
9		3.70	3.70	2.03		2.03	+1.67

CASE NO. 48.

	INTAKE						OUTPUT					N. BALANCE		URINE	SUCTION.
Date	Type of Food	Prot.	Fat	Carbo-hydrate	Cals.	Net N.	Urine Vol.	Urine N.	Stool N.	Suction N.	N. Loss	+	-	Chloride (as NaCl)	Chloride (as NaCl)
1948															
Jan. 12	F.	90	92	246	2172	14.40	2005	13.30	2.48		15.78		1.38	13.15	
13	F.	91	92	246	2176	14.56	1700	12.30	Nil		12.30	2.26		10.95	
14	F.	91	96	246	2212	14.56	1240	12.74	1.46		14.20	0.36		8.18	
15	F.	76	91	245	2103	12.16	1430	11.44	0.27		11.71	0.45		8.44	
16	OPERATION														
	M.M.	53	24	225	1328	8.48	265	2.66	Nil	2.56	5.22			1.38	2.90
17	M.M.	80	36	300	1844	12.80	965	13.06	Nil	5.29	18.35		5.55	5.70	5.62
18	M.M.	37	17	148	893	5.93	1210	17.09	Nil	0.56	17.65		11.72	5.18	0.85
19	F.	59	52	233	1636	9.44	920	20.53	Nil		20.53		11.09	2.26	
20	F.	72	61	269	1913	11.52	700	14.08	3.20		17.28		5.76	1.32	
21	F.	82	96	280	2312	13.12	700	16.27	Nil		16.27		3.15	1.33	
22	F.	90	78	268	2134	14.40	790	16.28	3.16		19.44		5.04	1.47	
23	F.	94	84	229	2048	15.04	740	14.19	Nil		14.19	0.85		2.07	
24	F.	88	88	239	2100	14.09	1540	12.80	Nil		12.80	1.29		6.16	
25	F.	85	86	224	2010	13.76	1060	13.08	2.12		15.20		1.44	4.21	
26	F.	91	92	246	2176	14.56	1020	13.12	1.76		14.88		0.32	7.98	

M.M. = Milk Mixture
F. = Ordinary Food

Case No. 48.

Chloride Balance (as NaCl.)

	Intake			Output			Balance
Date	0.9% saline	Milk mixt.	Total	Urine	Suction	Total	g
Op.	7.2	2.96	10.16	1.38	2.90	4.28	
Jan. 17		4.44	4.44	5.70	5.62	10.32	-6.88
18		1.97	1.97	5.18	0.85	6.03	-4.06
19		2.36[x]	2.36	2.26		2.26	+0.10
20		3.41[x]	3.41	1.32		1.32	+2.09
21		3.89[x]	3.89	1.33		1.33	+2.56
22		4.15[x]	4.15	1.47		1.47	+2.68

[x] Approximations of salt content of food.

CASE No. 49

DATE.	Type of food	Prot.	Fat	Carb.	Cals.	N Intake	Urine vol.	Urine N	Stool N	Suction N	N Loss	N. Balance +	N. Balance -	Body wt. in lb.	Temp. in $0^{o}F$	Urine Chlor. (As NaCl)	Suction Chlor (as NaCl)
1948																	
Jan. 27	F	88	93	246	2173	14.09	1280	10.42	0.41		10.83	3.26					
28	F	88	93	246	2173	14.00	1400	14.38	1.20		15.58		1.49				
29	F	88	93	246	2173	14.00	1340	8.42	0.67	1.62	10.71	3.38		147.9			
	OPERATION[x]																
30	M.M.	54	24	230	1352	8.65	825	10.79	nil	1.22	12.01				99		
31	M.M.	89	36	285	1820	14.24	760	17.55	nil	nil	17.55		3.31	140.1			
Feb. 1	M.M.	89	36	285	1820	14.24	785	21.65	nil	2.79	24.44		10.20		99.8		
2	M.M. & F	65	48	206	1516	10.40	570	16.65	1.90		18.55		8.15	141.6			
3	M.M. & F	87	53	282	1953	13.90	790	18.65	nil		18.65		4.75				
4	M.M. & F	86	72	238	1944	13.75	980	18.80	2.76		21.56		7.81	143.2			
5	F	73	73	206	1773	11.68	lost		nil					141.0	98.8		
6	F	88	55	225	1747	14.09	940	13.56	0.96		14.52		0.43	141.0			
7	F	90	75	249	2031	14.40	780	12.08	nil		12.08	2.32					
8	F	88	74	242	1986	14.09	1000	15.04	1.96		17.00		2.91	140.5			
9	F	76	76	217	1856	12.16	830	10.24	2.20		12.44		0.28	139.75			

430 ml. blood transfused ≡ 11.1 gm.N.
Blood lost contained 4.44 gm.N.
Stomach resected contained 2.98 gm.N.

M.M. = Milk Mixture
F = Ordinary food.

Case 49.

Chloride Balance (as NaCl)

	Intake (g)			Output(g)			Balance
Date	0.9% saline	Milk mixt.	Total	Urine	Suction	Total	g
Op.	7.2	2.96	10.16	2.43		2.43	
Jan. 31		4.44	4.44	1.87		1.87	+2.57
Feb. 1		4.44	4.44	1.68	1.30	2.98	+1.46
2	food 1.0	2.22	3.22	0.94		0.94	+2.28
3	1.0	2.22	3.22	3.49		3.49	-0.27

CASE No. 50.

DATE		INTAKE					OUTPUT					N BALANCE			
DATE		PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.
1948 Feb.	24	87	87	277	2239	13.92	1660	10.22	nil		10.22	3.70			
	25	84	92	267	2232	13.44	2350	10.34	0.86		11.20	2.24			
	26	90	93	267	2265	14.40	2490	12.50	2.42		14.92		0.52	104.7	
	27	87	91	265	2227	13.92	2010	10.77	1.50		12.27	1.65			
	28	90	93	267	2265	14.40	1900	9.80	0.88		10.68	3.72			
	29	89	84	262	2160	14.24	1630	8.18	1.54		9.72	4.52			
Mar.	1	90	93	267	2265	14.40 ?	1515	6.08	0.16	0.45	6.69				
	2	Operation*			nil	nil	nil	nil	nil	0.25					99.8
	3				nil	nil	1410	18.25	nil	0.18	18.43		18.43	104.5	101.5
	4	14	15	35	331	2.24	1060	17.0	nil		17.70		14.76	105.5	102.4
	5	42	46	144	1158	6.72	800	9.15	nil		9.15		2.43	104.5	101.0
	6	48	46	117	1074	7.68	950	8.38	7.28		15.66		7.98		99.6
	7	48	46	117	1074	7.68	1580	8.90	3.60		12.50		4.82	102.4	100.4
	8 /														

* Blood lost contained 1.44 g N

CASE No. 50 (Contd.)

	INTAKE					OUTPUT					N BALANCE			
DATE	PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT in LBS.	BODY TEMP. °F.
1948 Mar. 8	56	46	141	1234	8.98	1520	9.12	0.84		9.96		0.98		99.0
9	64	67	147	1447	10.24	1690	11.60	1.46		13.06		2.81	101.75	
10	66	66	192	1626	10.56	1020	7.45	nil		7.95	2.63			
11	68	68	209	1639	10.88	1220	7.75	1.62		9.37	0.53		101.0	
12	82	82	195	1828	13.12	720	5.62	1.56		7.18	5.96			

CASE NO. 50.

DATE		URINARY CHLORIDE (as NaCl)	SODIUM				CHLORIDE			
			TOTAL INTAKE	URINE	BALANCE +	BALANCE -	TOTAL INTAKE	URINE	BALANCE +	BALANCE -
Feb.	25	6.70	3.86	2.66	1.20		6.14	4.16	1.98	
	26	4.58	3.57	1.69	1.88		5.73	2.78	2.95	
	27	3.86	3.20	1.79	1.41		4.87	2.34	2.53	
	28	4.06	3.07	1.46	1.61		4.75	2.46	2.29	
	29	2.51	2.84	0.97	1.87		4.50	1.52	2.98	
Mar.	1	2.09	2.16	1.24	0.92		3.37	1.27	2.10	
		OPERATION								
	2	nil	4.86	0.07^{S}	4.79		7.52	0.16^{S}	7.36	
	3	9.70	3.87	3.59^{S}	0.28		5.82	6.15^{S}		0.30
	4	7.30	3.88	2.54	1.34		6.07	4.43	1.64	
	5	6.85	3.81	2.37	1.44		6.09	4.16	1.93	
	6	4.72	3.19	1.55	1.64		5.05	2.86	2.99	
	7	5.18	3.35	1.48	1.87		5.24	3.14	2.10	
	8	3.26	3.40	1.09	2.31		5.45	1.96	3.49	
	9	1.83	3.05	1.21	1.84		4.88	1.11	3.77	
	10	1.56	1.51	1.04	0.47		2.57	0.95	1.62	
	11	3.64	1.91	1.67	0.24		2.89	2.21	0.68	
	12	3.24	1.68	1.54	0.14		2.77	1.97	0.80	

S - valued for salt lost in gastric aspirations included.
No allowance made for salt lost in stools.

CASE No. 51.

DATE		INTAKE					OUTPUT					N BALANCE		
DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	MAXIMUM BODY TEMP. $^{\circ}F$
Apr.	23	92	105	297	2501	14.72								Normal
	24	92	96	297	2420	14.72	700	12.05	0.66		12.71	2.01		"
	25	92	105	297	2501	14.72	650	9.42	0.98		10.40	4.32		"
	26	92	105	299	2509	14.72	440	7.88	0.90		8.78	5.94		"
	27	76	95	251	2163	12.16	750	13.00	0.36		13.36		1.20	"
	28	92	105	299	2509	14.72	585	8.32	0.82		9.14	5.58		"
	29	92	105	299	2509	14.72	840	11.09	0.98		12.07	2.65		"
	30	OPERATION					250	2.67	nil	0.40	3.07			"
May	1	nil	nil	40	160	nil	750	14.14	nil	0.51	14.65		14.65	100
	2	nil	nil	40	160	nil	770	14.52	nil	0.47	14.99		14.99	101
	3	nil	nil	40	160	nil	760	12.20	nil	0.92	13.12		13.12	100.8
	4	18	12	36	324	2.88	1010	22.90	1.24		24.14		21.26	99
	5	16	16	36	352	2.56	745	18.65	nil		18.68		16.09	100.8
	6	48	41	127	1069	7.68	260	21.10	0.39		21.49		13.81	101.6
	7	64	75	168	1603	10.24	780	15.00	1.28		16.28		6.04	101.2
	8	70	77	191	1737	11.20	1310	17.35	0.94		17.82		6.62	100.8
	9	83	74	207	1826	13.28	1020	13.25			13.72		0.44	100
	10	91	87	227	2055	14.56	1240	14.95	nil		14.95		0.39	99
	11	90	96	225	2124	14.40	1120	18.75	0.60		19.35		4.95	101
	12	89	96	220	2100	14.24	1040	18.30	3.63		21.93		7.69	99.6
	13	91	104	270	2380	14.56	1210	18.21	1.62		19.83		5.27	100.4
	14	95	93	258	2209	13.61	1155	17.60	1.02		18.62		5.01	100.8
	15	92	101	297	2465	14.72	1025	12.25	1.42		13.67	1.05		101.8
	16	92	101	297	2465	14.72	1600	16.89	1.33		18.22		3.50	100.6
	17	92	101	297	2465	14.72	1300	12.57	1.40		13.97	0.75		100
	18	92	101	297	2465	14.72	1110	11.65	1.04		12.69	2.03		98.4
	19	92	101	297	2465	14.72	950	11.25	nil		11.25	3.47		Normal
	20	92	101	297	2465	14.72	940	9.88	1.60		11.48	3.24		"
	21	92	101	297	2465	14.72	610	7.04	1.90		8.94	5.78		"
	22	88	97	298	2417	14.09	730	8.06	1.07		9.13	4.96		"
	23	88	97	298	2417	14.09	720	7.13	0.71		7.84	6.25		"
	24	88	97	298	2417	14.09	1020	8.85	nil		8.85	5.24		"

CASE No. 51.

DATE.			Urine chloride (as NaCl.)	Sodium Intake	Sodium Urine	Sodium Balance +	Sodium Balance −	Chloride Intake	Chloride Urine	Chloride Balance +	Chloride Balance −
1948	April	24	4.3	2.45	1.61	0.84		3.93	2.61	1.32	
		25	1.69	2.41	0.49	1.92		3.86	1.03	2.83	
		26	2.70	2.39	0.93	1.46		3.86	1.64	2.22	
		27	5.62	2.37	2.27	0.10		3.84	3.41	0.43	
		28	6.24	2.44	2.45		0.01	3.86	3.78	0.08	
		29	6.11	2.38	2.79		0.41	3.85	3.71	0.14	
		OPERATION									
		30	1.73	4.26	0.49			6.56	1.44[s]		
	May	1	3.0	2.84	1.74[s]	1.10		4.37	2.70[s]	1.67	
		2	1.11	2.84	0.98[s]	1.86		4.37	1.68[s]	2.69	
		3	0.18	2.84	1.61[s]	1.23		4.37	2.85[s]	1.52	
		4	0.06	1.82	0.52	1.30		2.68	0.04	2.64	
		5	0.19	1.82	lost			2.85	0.11	2.74	
		6	0.79	2.32	1.01	1.21		3.76	0.48	3.28	
		7	1.69	3.04	1.45	1.59		4.93	1.03	3.80	
		8	6.81	2.73	3.87		1.14	4.42	4.14	0.28	
		9	7.84	2.77	3.72		0.95	4.57	4.57		0.18
		10	11.12	3.11	4.57		1.46	5.00	6.76		1.76
		11	9.24	2.10	3.09		0.99	3.45	5.61		2.16
		12	5.97	3.01	1.87	1.14		4.79	3.62	1.17	
		13	7.57	2.80	2.46	0.46		4.46	4.60		0.14
		14	7.35	3.05	2.58	0.43		4.86	4.46	0.40	
		15	6.53	2.77	2.30	0.37		4.45	3.96	0.49	
		16	7.28	3.06	2.70	0.36		4.85	4.42	0.43	
		17	6.43	3.17	2.51	0.66		5.06	3.90	1.16	
		18	4.82	2.83	1.83	1.00		4.54	2.92	1.62	
		19	4.75	2.43	1.97	0.46		3.92	2.88	1.04	
		20	7.88	2.82	3.40		0.58	4.51	4.78		0.27
		21	6.07	2.68	2.26	0.32		4.27	3.68	0.59	
		22	7.18	2.94	2.92	0.02		4.68	4.36	0.32	
		23	7.06	2.66	2.64	0.04		4.40	4.28	0.12	
		24	7.34	2.67	2.48		0.19	4.28	4.45		0.17

s - values for salt lost in gastric aspirations included.
No allowances made for salt lost in stools.

CASE No. 52

DATE		PROT.	FAT	CARB.	CALS.	N INTAKE	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	BODY TEMP. °F.
1948 Aug.	14	91	101	314	2529	14.55	1160	10.47	0.32		10.79	3.76			
	15	86	87	289	2283	13.78	1030	11.99	3.26	2.81	18.06		4.28		
	16	43	58	122	1182	6.88	490	5.16	0.54	0.53	6.23	0.65		107.5	
	17	91	101	314	2529	14.55	1230	13.26	0.31		13.57	0.98			
	18	88	98	330	2554	14.08	1360	13.28	0.11		13.39	0.69		108.4	
	19	70	92	291	2272	11.20	1340	9.16	1.19	0.08	10.43	0.77		108.75	
	20	Operation*		45			nil	nil	nil	0.60	2.57				
	21			38	152	nil	2100	23.00	nil	0.27	23.27		23.27	107.25	99
	22	11	10	18.9	212	1.75	1440	22.90	nil		22.90		21.15	106.75	99
	23	22	24	73	596	3.52	380	5.38	12.44		17.82		14.30	106.2	101
	24	43	53	99	1045	6.89	1260	17.56	3.41		20.97		14.08	105.4	
	25	54	66	126	1314	8.65	870	12.62	2.22		14.84		6.19		
	26 /														

* 390 ml blood transfused ≡ 8.76 g. N. Blood lost contained 1.85 g. N.
Stomach resected contained 1.12 g N.

CASE No. 52 (Contd.)

DATE	INTAKE PROT.	FAT	CARB.	CALS.	N INTAKE	OUTPUT URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	N BALANCE +	-	BODY WT. in LBS.	BODY TEMP. °F.
1948 Aug. 26	79	86	172	1778	12.66	1100	12.96	nil		12.96		0.30	102.4	
27	87	93	242	2153	13.92	1190	11.24	lost					105.8	
28	87	99	282	2367	13.92	1350	9.94	2.34		12.28	1.64		105.8	
29	101	106	310	2598	16.16	1170	10.34	1.68		12.02	4.14		105.25	
30	101	100	310	2544	16.16	990	9.10	0.64		9.74	6.42		104.25	
31	101	100	310	2544	16.16	1470	11.73	3.32		15.05	1.11		104.25	
Sept. 1	89	101	310	2505	14.24	1360	8.56	1.68		10.24	4.00		103.5	
2	89	101	310	2505	14.24	990	6.50	1.56		8.06	6.18		103.5	
3	89	101	310	2505	14.24	1110	7.08	1.66		8.74	5.50		103.5	
4	82	101	300	2437	13.12	1340	8.60	2.08		10.68	2.44		104.1	
5	72	78	292	2158	11.68	1500	6.12	1.02		7.14	4.54			

CASE No. 52 (Contd.)

DATE	URINE Cl. as NaCl	SODIUM TOTAL INTAKE	SODIUM URINE	SODIUM STOOL	SODIUM SUCTION	SODIUM TOTAL LOSS	SODIUM BALANCE +	SODIUM BALANCE −	CHLORIDE TOTAL INTAKE	CHLORIDE URINE	CHLORIDE STOOL	CHLORIDE SUCTION	CHLORIDE TOTAL LOSS	CHLORIDE BALANCE +	CHLORIDE BALANCE −
1948 Aug. 14	6.90	2.22	2.73	–		2.73			3.70	4.18		–	4.18		
15	4.10	1.81	1.66	not estimated	0.32	1.98			3.47	2.49	not estimated	2.39	4.88		
16	0.76	2.51	0.43		0.21	0.64			1.84	0.46		0.55	1.01		
17	0.54	5.16	2.05		nil	2.05			3.90	0.33		nil	0.33		
18	1.09	4.05	3.30		nil	3.30			4.15	0.66		nil	0.66		
19	1.21	2.16	3.36		0.13	3.49			3.50	0.73		0.58	1.31		
	OPERATION														
20	1.15	3.49	0.31	nil	nil	0.31			5.37	0.70	nil	0.12			
21	7.64	2.27	4.98	nil	0.15	5.03		2.86	3.51	4.63	nil	0.52	5.15		1.64
22	4.84	3.27	1.82	nil	nil	1.82	1.35		5.11	2.94	nil		2.94	2.15	
23	1.80	2.61	0.37	1.02		1.39	1.22		4.09	1.09	0.46		1.53	2.54	
24	1.66	2.40	0.18	0.79		0.97	1.43		4.00	1.01	0.97		1.98	2.02	
25	1.27	2.47	0.16	0.79		0.95	1.52		3.88	0.77	0.54		1.31	2.57	
26	2.42	3.02	0.34	nil		0.34	2.68		4.92	1.37	nil		1.37	3.55	
27	3.82	2.90	0.65	nil	nil	0.65	2.25		4.75	2.32	nil		2.32	2.43	
28	5.07	2.53	1.59	0.35		1.94	0.59		3.87	3.08	0.22		3.30	0.57	
29 /															

CASE No.52 (Contd.)

DATE	URINE Cl. as NaCl.	SODIUM TOTAL INTAKE	URINE	STOOL	SUCTION	TOTAL LOSS	BALANCE +	BALANCE −	CHLORIDE TOTAL INTAKE	URINE	STOOL	SUCTION	TOTAL LOSS	BALANCE +	BALANCE −
~~1948~~															
Aug. 29	5.08	2.98	1.71	0.20		1.91	1.07		4.35	3.09	0.17		3.26	1.11	
30	4.17	2.91	1.41	0.34		1.75	1.14		4.58	2.43	0.07		2.50	2.08	
31	6.37	2.72	2.51	0.25		2.76		0.04	4.38	3.87	0.12		2.99	0.39	
Sept. 1	4.74	2.42	2.33	0.14		2.47		0.05	3.95	2.88	0.06		2.94	1.01	
2	3.70	2.65	1.51	0.02		1.53	1.08		4.32	2.25	0.05		2.30	2.02	
3	3.86	2.53	1.47	0.04		1.51	1.02		4.09	2.32	0.04		2.36	1.73	
4	5.23	2.44	2.05	0.05		2.10	0.34		3.94	3.18	0.05		3.23	0.71	
5	4.48	2.23	1.74	0.10		1.84	0.49		3.62	2.72	0.05		2.77	0.85	

CASE No. 53.

		INTAKE					OUTPUT					N BALANCE	
DATE		PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	−
June	3	92	101	311	2523	14.72	1340	16.00	1.58		17.58		2.86
	4	92	101	311	2523	14.72	980	12.75	nil		12.75	1.97	
	5	92	101	313	2531	14.72	820	11.90	nil		11.90	2.82	
	6	92	101	311	2523	14.72	800	12.00	0.42		12.42	2.30	
	7	92	101	309	2515	14.72	870	13.00	0.39		13.39	1.33	
	8	92	101	313	2531	14.72	810	11.91	0.50		12.41	2.31	
	9	92	101	311	2523	14.72	850	12.08	0.50		12.58	2.14	
	10	92	101	311	2523	14.72	1570	16.20	nil	0.16	16.36		1.64
	11	Operation*		25			300	2.76	nil	lost	18.37	3.85	
	12	nil	nil	80	320	nil	1580	14.05	nil	lost	14.05		14.05
	13	nil	nil	40	160	nil	700	6.02	nil	lost	6.02		6.02
	14	3	2	32	160	0.47	1300	15.12	nil	lost	15.12		14.65
	15/												

* 835 ml. blood transfused ≡ 22.22 g N.
blood lost contained 13.75 g N.
Stomach resected contained ≡ 1.86 g N.

CASE No. 53 (Contd.)

	INTAKE					OUTPUT					N BALANCE	
DATE	PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-
June 15	13	13	59	405	2.08	950	19.00	nil	0.46	19.46		17.38
16	54	58	157	1366	8.66	700	14.90	1.14		16.04		7.38
17	56	66	119	1294	8.97	360	6.74	nil		6.74	2.23	
18	71	78	205	1806	11.35	770	13.00	0.71		13.71		2.36
19	82	85	233	2025	13.15	820	11.35	nil		11.35	1.80	
20	89	92	293	2140	14.25	1190	12.92	4.66		17.58		3.33
21	87	89	244	2125	13.92	1780	13.50	nil		13.50	0.42	
22	90	89	244	2137	14.40	1450	11.72	2.76		14.48		0.08
23	95	89	244	2157	15.20	1550	13.64	0.34		13.98	1.22	
24	90	89	244	2137	14.40	1180	12.55	lost		12.55	1.85	
25	90	89	244	2137	14.40	1770	11.03	nil		11.03	3.37	

CASE No. 53.

DATE	URINARY CHLORIDE (as NaCl)	SODIUM TOTAL INTAKE	SODIUM URINE	SODIUM BALANCE +	SODIUM BALANCE −	CHLORIDE TOTAL INTAKE	CHLORIDE URINE	CHLORIDE BALANCE +	CHLORIDE BALANCE −
1948 June 3	9.06	2.86	4.21		1.35	4.48	5.50		1.02
4	9.02	2.82	4.17		1.35	4.40	5.48		1.08
5	7.60	2.86	3.38		0.52	4.48	4.62		0.14
6	7.55	2.62	3.32		0.70	4.14	4.58		0.44
7	8.52	2.70	3.63		0.93	4.22	5.18		0.96
8	7.62	2.87	3.03		0.16	4.49	4.57		0.08
9	8.41	2.86	3.61		0.85	4.48	5.12		0.64
10	11.99	2.63	4.38		1.75	4.14	7.29		3.15
	OPERATION								
11	2.14	1.77	0.78			2.74	1.30		
12	8.16	2.83	3.05		0.22	4.37	4.97		0.60
13	1.34	2.83	0.78	2.05		4.37	0.82	3.55	
14	0.99	0.04	0.76		0.74	0.07	0.60		0.53
15	0.51	0.22	0.44		0.22	0.37	0.31	0.06	
16	0.55	2.10	0.63	1.47		3.42	0.33	3.09	
17	0.56	2.84	0.52	2.32		4.46	0.34	4.12	
18	1.64	3.32	1.25	2.07		5.22	1.00	4.22	
19	3.36	3.48	1.51	1.97		5.56	2.04	3.52	
20	5.95	3.67	2.28	1.39		6.09	3.61	2.38	
21	8.25	3.88	2.93	0.95		6.11	5.00	1.11	
22	6.73	3.16	2.69	0.47		5.01	4.08	0.93	
23	7.93	3.10	2.90	0.20		4.88	4.81	0.07	
24	8.25	3.13	3.18		0.05	4.95	5.01		0.06
25	7.44	2.28	2.66		0.38	3.64	4.51		0.87

CASE No. 54.

DATE	INTAKE					OUTPUT					N BALANCE			
	PROTEIN	FAT	CARB.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY TEMP. in °F.
1948 July 5	73	77	223	1877	11.68	740	8.26	0.32		8.58	3.10		
6	96	101	318	2565	15.36	1060	9.36	0.24		9.60	5.76		
7	92	98	313	2502	14.72	810	9.75	0.11		9.89	4.83		
8	82	99	301	2423	13.18	1080	9.66	0.89		10.55	2.63		
9	Operation *		20	80		660	5.60	nil					
10			60	240	nil	700	10.80	nil	2.08	12.88		12.80	
11			40	160	nil	530	10.60	nil	1.63	11.23		11.23	
12	28	34	90	778	4.48	730	14.73	nil	0.15	14.88		10.40	
13	54	59	144	1323	8.66	500	11.32	0.68		12.00		3.34	
14	77	72	199	1752	12.38	830	15.31	nil		15.31		2.93	
15	78	87	202	1903	12.54	820	14.02	1.62		14.02		1.48	
16	88	101	293	2433	14.08	870	15.19	nil		15.19		1.11	
17	88	101	293	2433	14.08	800	12.52	0.68		13.20	0.88		
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CASE No. 54. (Contd.)

	INTAKE					OUTPUT					N BALANCE		
DATE	PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY TEMP. IN °F.
1948 July 18	84	85	279	2217	13.44	760	10.56	1.00		11.56	1.88		
19	62	81	228	1889	9.92	840	12.34	1.32		13.66		3.74	
20	84	96	241	2164	13.44	840	12.90	1.00		13.90		0.54	100.4
21	67	74	206	1758	10.72	815	13.81	1.14		14.95		4.23	

CASE No. 54.

DATE	URINE CHLORIDE (as NaCl)	SODIUM INTAKE	SODIUM URINE	SODIUM BALANCE +	SODIUM BALANCE −	CHLORIDE INTAKE	CHLORIDE URINE	CHLORIDE BALANCE +	CHLORIDE BALANCE −
1948 July 5	5.32	1.65	1.94		0.29	2.82	3.22		0.40
6	7.96	3.34	2.90	0.44		5.34	4.83	0.51	
7	5.34	1.97	2.11		0.14	3.24	3.24	0	
8	4.42	2.86	1.62	1.24		4.59	2.68	1.91	
	Operation								
9	3.82	4.13	1.29			6.36	2.32		
10	3.58	2.54	1.96[S]	0.58		3.92	1.36[S]	0.58	
11	1.18	1.41	1.46[S]		0.05	2.17	2.45[S]		0.27
12	0.61	0.54	0.33[S]	0.31		0.92	0.55[S]	0.37	
13	0.34	2.11	0.13	1.98		3.37	0.21	3.16	
14	1.74	2.52	0.65	1.87		4.01	1.05	2.96	
15	3.31	2.92	1.32	1.60		4.59	2.01	2.58	
16	3.38	3.40	1.47	1.93		5.46	2.05	3.41	
17	4.45	3.30	1.70	1.60		5.06	2.70	2.36	

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CASE No. 54 (Contd.)

DATE	URINE CHLORIDE (as NaCl)	SODIUM				CHLORIDE			
		INTAKE	URINE	BALANCE		INTAKE	URINE	BALANCE	
				+	−			+	−
1948									
July 18	5.32	2.60	1.89	0.71		4.20	3.22	0.98	
19	5.37	2.37	1.96	0.41		3.66	3.26	0.40	
20	4.05	2.06	1.47	0.59		3.28	2.46	0.82	
21	3.29	2.03	0.73	1.30		3.32	2.00	1.32	

S = figures for suction fluid included.

No allowances made for stool salt lost.

CASE No. 55.

DATE.	Intake Prot.	Fat.	Carb.	Cals.	N Intake	Output Urine Vol.	Urine N	Stool N	Suction N	N loss	N Balance +	N Balance −	Body wt. in lb.	Body temp. °F
Oct. 3	91	101	330	2593	14.56	1500	10.56	nil		10.56	4.00			
4	91	101	330	2593	14.56	1760	9.10	1.36		10.46	4.10			
5	91	101	330	2593	14.56	1900	12.76	1.00		13.76	0.80			
6	91	101	330	2593	14.56	1200	11.38	nil		11.38	3.18			
7	91	101	330	2593	14.56	710	8.70	nil		8.70	5.86			
8	91	101	330	2593	14.56	1740	12.65	1.86		14.51	0.05			
9	91	101	333	2605	14.56	1480	9.64	nil		9.64	4.92			
10	91	101	330	2593	14.56	1880	13.60	1.34		14.94		0.38		
11	66	72	247	1900	10.56	1870	11.08	0.42	0.53	12.03		1.47	121.4	
	OPERATION													
12			20			1200	12.43	nil	1.56	13.99				
13	nil	nil	40	160	nil	710	12.38	nil	1.08	13.46		13.46		
14	nil	nil	18	72	nil	910	18.68	nil		18.68		18.68	121.0	101
15	19	20	68	525	3.04	900	20.20	nil		20.20		17.16	121.1	100
16	43	53	99	1045	6.88	1380	17.08	1.50		18.58		11.70	121.0	100.1
17	57	65	126	1317	9.12	930	12.58	1.56		14.14		5.02	120.9	100.2
18	70	80	153	1612	11.20	890	9.94	0.84		10.78	0.42		119.1	
19	88	91	213	2023	14.08	1030	10.44	3.52		13.96	0.12		117.9	
20	82	79	220	1919	13.12	670	3.48	7.10		10.58	2.54		117.45	
21	88	95	301	2411	14.08	1410	11.71	2.63		14.34		0.26	116.1	
22	65	96	262	2172	10.40	900	10.80	1.18		11.98		1.58	115.9	
23	87	104	253	2296	13.92	1510	11.95	nil		11.95	1.97		117.7	
24	86	101	263	2305	13.78	1110	6.19	3.16		9.35	4.43		117.4	
25	97	108	274	2456	15.52	1500	8.36	1.40		9.76	5.76		118.1	
26	91	105	267	2377	14.56	2200	10.29	1.96		12.25	2.31		117.9	
27	89	104	262	2340	14.24	1430	6.85	2.20		9.05	5.19		116.8	
28	91	106	268	2390	14.56	1270	5.72	1.04		6.76	7.80		117.5	

856 ml. blood transfused ≡ 17.32 g.N

Blood lost ≡ 18.7 g.N

Stomach resected contained = 2.88 g.N

CASE No. 55.

DATE	Urine chlor. as NaCl.	Sodium Total intake	Urine	Stool	Suction	Total Loss	Balance +	-	Chloride Total intake	Urine	Stool	Suction	Total loss	Balance +	-
1948															
Oct. 3	7.81	3.38	2.73	nil		2.73	0.65		5.16	4.76	nil		4.76	0.40	
4	6.86	2.98	2.47	0.10		2.57	0.41		4.59	4.17	0.05		4.22	0.37	
5	8.20	2.88	3.32	0.20		3.52		0.64	4.41	4.98	0.07		5.05		0.64
6	5.57	2.66	2.40	nil		2.40	0.26		4.10	3.38	nil		3.38	0.72	
	?volume of urine														
7	1.75	2.81	1.04	nil		1.04			4.32	1.06	nil				
8	5.57	2.81	2.80	0.10		2.90		0.09	4.31	3.38	0.02		3.40	0.91	
9	6.50	2.81	2.71	nil		2.71	0.10		4.31	3.92	nil		3.92	0.39	
10	8.27	2.80	2.77	0.12		2.89		0.09	4.45	4.80	0.02		4.82		0.37
11	3.78	1.84	2.13	0.20	0.54	2.87		1.03	2.94	2.30	0.04	1.25	3.59		0.65
	OPERATION														
12	3.65	2.60	1.30	nil	0.22				4.03	2.22	nil	0.31			
13	1.85	2.76	1.13	nil	0.61	1.74	1.02		4.27	1.12	nil	0.90	2.02	2.25	
14	1.90	1.30	0.58	nil		0.58	0.72		2.01	1.15	nil		1.15	0.86	
15	1.90	2.63	0.77	nil		0.77	1.86		4.14	1.15	nil		1.15	2.99	
16	4.42	3.40	1.91	0.28		2.19	1.21		5.37	2.68	0.07		2.75	2.62	
17	3.12	3.08	1.27	0.35		1.62	1.46		4.82	1.92	0.05		1.97	2.85	
18	2.83	2.28	1.56	0.31		1.87	0.41		3.71	1.72	0.05		1.77	1.94	
19	3.85	2.33	2.17	0.77		2.94		0.61	3.82	2.34	0.97		3.31	0.51	
20	1.39	2.25	0.45	1.72		2.17	0.08		3.45	0.84	2.60		3.44	0.01	
21	5.32	2.66	1.96	0.17		2.13	0.53		4.15	3.23	0.05		3.28	0.87	
22	4.46	2.13	1.58	0.18		1.76	0.37		3.33	2.70	0.02		2.72	0.61	
23	6.24	2.40	2.12	nil		2.12	0.28		3.74	3.75	nil		3.75		0.01
24	4.48	2.01	1.52	0.35		1.87	0.14		3.05	2.72	0.10		2.82	0.23	
25	7.50	2.63	2.64	0.36		3.00		0.37	4.19	4.57	0.12		4.69		0.50
26	8.20	2.19	3.20	0.17		3.37		1.18	3.29	4.98	0.04		5.02		1.73
27	4.86	2.17	1.74	0.10		1.84	0.33		3.53	2.96	0.04		3.00	0.53	
28	4.07	1.90	1.57	0.15		1.72	0.18		2.97	2.49	0.11		2.60	0.37	

CASE No. 55.

DATE	Potassium		Phosphorus				Sulphur			
	Intake	Urine	Intake	Excretion	Balance +	Balance -	Intake	Urine	Balance +	Balance -
Oct. 3	3.62		2.08	1.02	1.06		0.81	0.61		
4	3.47		2.07	1.03	1.04		0.81	0.53		
5	3.43	2.94	2.05	1.69	0.36		0.82	0.89		
6	3.42	2.54	2.03	1.63	0.40		0.81	0.79		
7	3.44	1.35	2.07	0.87	1.20		0.80	0.60		
8	3.44	3.34	2.05	1.72	0.33		0.82	0.94		
9	3.55	2.70	2.06	1.24	0.82		0.83	0.62		
10	3.40	2.70	2.05	1.63	0.43		0.82	0.96		
11	2.78	2.70	1.43	1.16	0.27		0.58	0.60		
	OPERATION									
12	nil	4.10	nil	2.17		2.17	nil	1.05		
13	nil	2.18	nil	1.09		1.09	nil	0.76		
14	nil	2.18	nil	1.22		1.22	nil	0.91		
15	0.96	0.98	0.51	0.51			0.15	1.22		
16	1.75	0.98	1.12	0.76	0.36		0.41	1.27		
17	1.98	0.51	1.25	0.47	0.78		0.54	0.84		
18	2.58	0.51	1.60	0.61	0.99		0.63	0.78		
19	3.26	0.33	2.09	1.01	1.08		0.79	0.68		
20	2.71	0.33	1.77	0.98	0.79		0.70	0.17		
21	3.44	1.31	2.14	1.57	0.57		0.78	0.72		
22	2.45	1.31	1.64	1.39	0.25		0.58	0.67		
23	3.03	1.30	2.10	1.56	0.54		0.84	0.76		
24	2.32	1.30	1.60	1.22	0.38		0.62	0.39		
25	3.39	1.70	2.32	1.57	0.75		0.84	0.62		
26	2.50	1.70	1.70	1.60	0.10		0.71	0.75		
27	3.05	1.24	2.14	1.12	0.02		0.84	0.32		
28	2.41	1.24	1.70	1.21	0.49		0.79	0.32		

CASE No. 56. HEIGHT: 5 ft. $3\frac{7}{8}$ ins.

	INTAKE					OUTPUT					N BALANCE			
DATE	PROTEIN	FAT	CARB.	CALS.	TOTAL N INTAKE	URINE VOL.	URINE N.	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	TEMP. °F.
1948 Dec. 1	90	101	318	2537	14.40									
2	91	101	330	2589	14.56	690	10.15	1.06		11.21	3.35			
3	84	87	282	2247	13.46	945	10.25	0.80		11.05	2.41			
4	91	101	316	2532	14.56	1260	11.26	nil		11.26	3.30			
5	98	105	315	2597	15.68	920	10.92	0.78		11.70	3.98			
6	91	101	330	2589	14.56	1310	11.39	1.56	0.44	13.39	1.17		100.1	
7	Operation*		20			350	4.08	nil		9.18				
8				nil	nil	910	11.21	nil	1.26	12.47		12.47		99.2
9				nil	nil	290	5.05	nil		5.05		5.05		
10	20	22	70	558	3.20	570	13.68	0.56		14.24		11.04	96.2	
11	38	46	96	950	6.08	520	11.38	1.38		12.76		6.68	97.0	99.0
12	57	65	126	1317	9.14	870	18.40	1.52		19.92		10.78	96.3	99.0
13 /														

*1 pt. blood transfused. Blood loss ≡ 5.1 g N
Stomach resected lost.

CASE No. 56. (Contd.)

		INTAKE					OUTPUT				N BALANCE			
DATE	PROTEIN	FAT	CARBO.	CALS.	TOTAL N	URINE VOL.	URINE N	STOOL N	SUCTION N	N LOSS	+	-	BODY WT. in LBS.	TEMP °F
1948 Dec. 13	80	87	164	759	12.82	700	12.21	2.38		14.59		1.77	96.4	
14	90	96	233	2156	14.40	600	8.18	4.00		12.18	2.22		96.3	
15	94	109	249	2353	13.64	440	6.78	2.82		9.60	4.04		95.5	

CASE: NO. 56.

DATE	URINE Cl (as NaCl)	SODIUM TOTAL INTAKE	URINE	STOOL	SUCTION	TOTAL LOSS	BALANCE +	BALANCE −	CHLORIDE TOTAL INTAKE	URINE	STOOL	SUCTION	TOTAL LOSS	BALANCE +	BALANCE −
1948 Dec. 2	4.74	2.89	1.90	–	–				4.49	2.88	.04		2.92	1.57	
3	6.24	2.52	2.52	–					3.99	3.78	.03		3.81	0.18	
4	6.78	2.70	2.36	nil		2.36	0.34		4.21	4.12	nil		4.12	0.09	
5	7.28	3.06	2.57	0.15		2.72	0.34		4.73	4.42	0.03		4.45	0.28	
6	6.69	2.88	2.37	0.34	0.29	3.00		0.12	4.43	4.05	0.05	0.18	4.28	0.15	
	OPERATION														
7	2.95	2.56	1.48	nil					3.94	1.79	nil				
8	7.17	2.40	3.19	nil		3.19		0.69	4.06	4.36	nil		4.36		0.30
9	1.73	2.27	0.64	nil		0.64	1.53		3.50	1.05	nil		1.05	2.45	
10	1.73	2.60	0.53	0.52		1.05	1.55		4.08	1.05			1.05	3.03	
11	3.23	2.33	0.99	0.41		1.40	0.93		4.00	1.96	0.12		2.08	1.92	
12	5.94	2.47	2.39	0.38		2.77		0.30	3.89	3.63	0.24		4.13		0.24
13	6.11	2.72	2.04	0.73		2.77		0.05	4.32	3.72	0.11		3.83	0.49	
14	4.24	2.96	1.40	0.84		2.22	0.74		4.78	2.57	0.54		3.11	1.67	

CASE: NO. 56

DATE	POTASSIUM IN-TAKE	URINE	STOOL	TOTAL LOSS	BALANCE +	BALANCE −	PHOSPHORUS IN-TAKE	URINE	STOOL	TOTAL LOSS	BALANCE +	BALANCE −	SULPHUR IN-TAKE	URINE	STOOL	TOTAL LOSS	BALANCE +	BALANCE −
1948 Dec. 2	3.31	1.58	0.25	1.83	1.48		2.00	0.55	0.45	1.00	1.00		0.80	0.69	0.13	0.82		0.32
3	3.12	2.02	0.30	2.32	0.80		1.87	0.51	0.46	0.97	0.90		0.73	0.80	0.15	0.95		0.12
4	3.26	2.19	nil	2.19	1.07		2.00	0.46	nil	0.46	1.54		0.78	0.82	Nil	0.82		0.04
5	3.43	2.16	0.26	2.42	1.01		2.03	0.58	0.30	0.88	1.15		0.91	0.83	0.11	0.94		0.03
6	3.38	1.88	0.63	2.51	0.87		2.05	0.51	0.43	0.94	1.11		0.82	0.80	0.24	1.04		0.22
7 OPERATION	nil	1.26	nil	1.26		1.26	nil	0.49	nil	0.49		0.49	nil	0.35	nil	0.35		0.35
8	nil	2.82	nil	2.82		2.82	nil	1.13	nil	1.13		1.13	nil	1.05	nil	1.05		1.05
9	nil	1.06	nil	1.06		1.06	nil	0.36	nil	0.36		0.36	nil	0.41	nil	0.41		0.41
10	1.03	1.57	0.48	2.05		1.02	0.58	0.56	0.19	0.75		0.17	0.16	1.00	0.08	1.08		0.92
11	1.59	0.95	0.38	1.33	0.26		1.00	0.29	0.28	0.57		0.43	0.37	0.67	0.14	0.81		
12	1.98	1.50	0.35	1.85	0.13		1.27	0.54	0 .08	0.62	0.55		0.53	1.11	0.12	1.23		
13	2.45	0.84	0.73	1.57	0.88		1.76	0.56	0.14	0.70	1.06		0.70	0.80	0.21	1.01		
14	3.40	0.52	1.24	1.76	1.64		2.11	0.35	0.46	0.81	1.30		0.80	0.59	0.28	0.87		
15	3.28	0.93	0.99	1.92	1.26		2.16	0.44	0.20	0.64	1.52		0.88	0.52	0.25	0.77		

CASE No. 15.

DATE		ALB.	GLOB.	TP.	ALB./GLOB.	N.P.N.	CREAT.	BlCl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947	Jan. 8	3.75	2.50	6.25	1.50	15	1.6	440		50	5.06	106
	9	OPERATION										
	14	3.51	2.85	5.36	1.23	27	1.6	430	68	44	4.86	96
	16	3.55	3.00	6.55	1.18	12	1.6	412	64	45.5	5.09	106
	21	3.50	3.26	6.76	1.07	14	1.3	424	64	42	4.74	98
	23	3.98	2.58	6.56	1.54	14	1.2	432	61			

CASE No. 16.

DATE			ALB.	GLOB.	T.P.	ALB./GLOB.	B.U.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947	Jan.	14	4.50	2.08	6.58	2.16	16				46.5	5.01	108
		16			6.62		16	1.1	412	61	47	5.08	114
		17	OPERATION										
		21	3.75	2.60	6.15	1.28	11	1.2	396	75	45	4.73	104
		23	3.69	2.60	6.29	1.42	17	1.0	460	56	43	5.07	100
		27	4.14	2.45	6.59	1.69	15	1.3		65	44	5.11	100
		30	3.99	3.00	6.99	1.33	13	1.7	428	63	46.5	5.29	108

CASE No. 17.

DATE			ALB.	GLOB.	T.P.	$\frac{\text{ALB.}}{\text{GLOB.}}$	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2CP.	P.C.V.
1947	July	10	3.50	1.80	5.30	1.95	27	4.80		444	63	
			OPERATION									
		11								436	61	
		14	3.40	1.90	5.30	1.79	19	4.98	2.50	430	62	37
		17	3.20	2.10	5.30	1.52	17		2.00	452	58	38
		25	2.40	2.40	4.80	1.00	14		1.50	456	63	33
		29					14		1.30	440	58	

CASE No. 18.

DATE			ALB.	GLOB.	T.P.	$\frac{ALB.}{GLOB.}$	B.U.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947	Feb.	13	4.05	2.10	6.15	1.93	16	1.2	458	62	49.5	5.30	
		17	4.06	1.98	6.04	2.03	17	1.6	480	67	45.0	5.00	
		20	4.35	1.80	6.15	2.42	16		440	73	47.5	5.19	
		21	OPERATION										
		24	3.51	2.51	6.02	1.40	26		442		42	4.60	
		26					21		424				
		27	3.60	2.43	6.03	1.48	20	1.0	432	66	41	4.51	
	Mar.	3	3.75	2.40	6.15	1.56	15	1.1	460	66	43	4.64	
		6	3.31	2.33	5.64	1.42	11	1.2	472	58	42.5	4.59	96
		10	3.40	2.23	5.63	1.52	12	0.9	468	71	39	4.21	90

CASE No. 32.

DATE	ALB.	GLOB.	T.P.	$\frac{\text{ALB.}}{\text{GLOB.}}$	N.P.N.	Bl.Cl.	P.C.V.	R.B.C.	Hb.
Nov. 1	4.15	2.53	6.68	1.64			50.5	5.43	114
5					34	352			
7	4.29	2.13	6.42	2.02		362	50.5	5.10	110
11						450	51.5	5.58	114
12	OPERATION								
14	3.74	2.63	6.37	1.42	34		41.5	4.61	94
18	3.75	2.63	6.38	1.43	32		40.0	4.68	96
21	3.88	2.60	6.48	1.49	32		43.0	4.81	98

CASE No. 34.

DATE	ALB.	GLOB.	T.P.	ALB./GLOB.	N.P.N.	CREAT.	Bl.Cl.	P.C.V.	R.B.C.	Hb.
1946 Nov. 25	4.05	2.08	6.13	1.94	28		446			
28	3.95	2.26	6.21	1.75	40	1.1	458	45.5	5.32	106
Dec. 2	4.13	2.88	7.01	1.43	36					
3	OPERATION									
5	3.51	2.83	6.34	1.24	38	1.2	424	39.5	4.94	100
9	3.51	2.23	5.74	1.57	43	1.2	460	38.5	4.51	92
12	3.57	3.23	6.80	1.10	25	1.1	480	41	5.09	94
17	3.56	3.38	6.94	1.05	26	1.3	474	41	5.05	98
19	3.66	2.95	6.61	1.24	26	1.3	480	39	4.15	88

CASE No. 35.

DATE			ALB.	GLOB.	T.P.	ALB./GLOB.	N.P.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1946	Nov.	28	4.04	2.50	6.54	1.62	37		444		49	6.00	120
	Dec.	2	4.26	2.23	6.49	1.91	38	1.2	444		47.5	5.73	116
		4	4.10	2.88	6.98	1.42	34	1.1	430		46	5.96	114
		5	OPERATION										
		9	4.07	2.25	6.32	1.81	41	1.8	400	59	43.5	4.98	104
		12	2.80	3.14	5.94	0.89	25	1.1	412	61	39.5	4.84	90
		17	3.88	2.55	6.43	1.52	24	1.2	436	70	40	4.94	94
		19	2.73	2.83	5.56	0.97				62	42.5	4.86	94

CASE No. 36.

DATE	ALB.	GLOB.	T.P.	ALB./GLOB.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947 April 28	4.49	2.15	6.64	2.09	21	4.76	1.20	456	62		1	
May 1			6.56		15	4.40	1.7	428	60	51	5.51	120
	OPERATION											
2						5.56	1.2	420	62			
3						5.84			70	48	5.33	110
5	3.19	1.98	5.17	1.61	39	4.76	1.1	440	67			
8	3.15	2.08	5.23	1.52	20	4.50	1.0	480	54	40	4.54	88
10					14	5.30		472				
12	3.45	2.08	5.53	1.66	18	5.60	1.5	480	55	43	4.89	100
15	3.58	2.65	6.23	1.40	22	5.50	1.2	460	55	42	4.91	96

CASE No. 37.

DATE	ALB.	GLOB.	T.P.	ALB./GLOB.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947 May 12	3.60	1.75	5.35		16	6.0	1.3	472	61	46	5.41	104
	PRE-OP.		5.63		18	6.1	1.0	444	62	49	5.45	110
15	OPERATION											
	2.35 p.m.					6.0		448	59			
	3.20 p.m.					6.0		444	54			
16					16	4.8		410	63			
18					16	4.9	0.9	450	67			
19	2.96	2.05	5.01		17		0.9	444				
23	3.06	2.25	5.31		16	4.6	0.6	456	58	39		92
26	3.30	2.30	5.60		12	4.4	0.9	460	60	42	4.95	96
29	4.20	1.60	5.80		16			468	61	41	4.67	90

CASE No. 38.

DATE	ALB.	GLOB.	T.P.	ALB./GLOB.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.
July 14	4.6	3.2	7.8	1.44	19	6.5	2.0	390	63	38
15	OPERATION									
16						4.98				
17	4.2	2.6	6.8	1.61	21	4.78	2.5	460	62	35
18						4.78				
19						4.78				
21						4.57				
25	3.0	2.8	5.8	1.07	16	4.80	1.6	480	58	30
29	3.0	3.5	6.5	0.86	20	5.10	1.8	464	59	31

CASE No. 39.

DATE			ALB.	GLOB.	T.P.	ALB./GLOB.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.
1947	July	14	3.8	2.5	6.3	1.52	17	5.30	1.8	424	67	49
		17	3.6	2.7	6.3	1.32	15	4.60	2.1	404	67	50
		17	OPERATION									
		19						5.10				
		21						4.94				
		22						5.10				
		25	2.8	3.0	5.8	0.93	13	4.80	1.5	452	58	36
		29	2.2	3.6	5.8	0.61	16	5.30	1.5	414	54	36

CASE No. 43.

DATE			ALB.	GLOB.	T.P.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	Hb.
1947	Oct.	21	3.01	2.30	5.31	14	6.20	1.6	460	74	46		
		23	3.79	1.73	5.52	13	5.20	1.5	430	70	46	5.66	112
		30	3.46	2.20	5.66	14	4.80	1.9	420	63	44	5.09	100
	Nov.	3				12		1.8	460		47	4.88	106
		6	3.75	1.95	5.70	9	4.38	1.7	454	66	43	4.77	98
		10	3.68	1.95	5.63	15	6.90	1.7	420	65	43	4.78	104
		13	4.20	2.08	6.28	13	6.50	1.9	420	61	46	4.92	110
		17	3.93	1.98	5.91	17		1.7	404	69	45	5.21	90
		20	4.02	2.00	6.02	12	6.08	1.7	420	68		5.18	106
		24	3.73	1.85	5.58	12	7.42	1.8	430	69	44	4.88	90
		28			5.82	11	6.08	1.5	404	64	45	5.22	100
	Dec.	4	3.44	2.29	5.73	16	6.10	1.8	424	70	43		90
		10	3.78	1.98	5.76	11	5.90	1.5	430	61	43	4.95	104

CASE No. 45.

DATE	ALB.	GLOB.	T.P.	$\frac{\text{ALB.}}{\text{GLOB.}}$	N.P.N.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.
Nov. 10	4.05	1.98	6.03	2.04	24	14	5.44	1.90	410	66	44
11	OPERATION										
13	4.43	2.38	6.81	1.56	27	14	5.30	1.70	400	65	45
17	3.94	2.28	6.22	1.73	42	20		1.80	424	60	
20						16	4.76	1.70	410	61	
24	3.47	1.98	5.45	1.75	41	14	4.38	1.90	404	63	

CASE No. 46.

DATE		ALB.	GLOB.	T.P.	ALB./GLOB.	N.P.N.	B.U.N.	P.A.N.	CREAT.	Bl.Cl.	CO_2C.P.	P.C.V.	R.B.C.	HB.
Nov.	20	4.33	2.50	6.83	1.73	24	13	4.76	1.8	400	64	51	5.37	112
	24	4.19	2.25	6.44	1.86	47	12	5.30	1.8	430	64	54	5.35	110
	25	OPERATION												
	27	4.10	2.25	6.35	1.52	68	37	5.10	1.8	364	64	52	5.31	110
Dec.	1	3.80	2.20	6.00	1.72	68	33	4.76	2.0	370	59	45	4.95	92
	4			5.06		38	17	5.43	2.1	410	52	40	4.57	92
	8	3.13	2.18	5.31	1.44	38	17	5.16	1.7	420	57	42	4.48	94
	11	3.24	2.20	5.44	1.46	37	21	5.43	1.8	440	61			

CASE No. 48.

DATE			N.P.N.	B.U.N.	CREAT.	U.A.	B.A.N.	Bl.Cl.	P.C.V.
1948	Jan.	15	42.4	25.6			11.05	444	41
		16	OPERATION						
			36.8	18.4	1.42	4.46	10.40		44
		17	38.8	17.5	1.38	3.32	9.75	474	38
		18	36.8	19.5	1.35	3.16	9.75	456	40
		19	39.2	24.2	1.33	3.00		448	39
		20	43.2	25.2	1.40	3.15	10.56		39
		21	41.6	22.9	1.40	3.05	11.42	458	38
		22	42.4	22.9	1.40	3.14	10.40	474	38
		23	39.6	21.1	1.40	3.68	10.40	456	38

CASE No. 49.

DATE	N.P.N.	B.U.N.	CREAT.	U.A.	B.A.N.	Bl.Cl.	P.C.V.
1948 Jan. 30	OPERATION						
31	52.8	19.5	1.38	3.9	9.88	446	49
Feb. 1	44	17.5	1.33	2.9	10.14	436	47
2	55.2	24.5	1.30	2.6	10.14	416	45
3	45.6	22.1	1.30	3.3		420	44
4	48.8	18.0		2.2	8.96	416	45
5	43.6	17.5	1.20	3.3	8.59	426	46
6	40	17.7	1.20	3.2	8.20	428	46
7		17.4	1.25	3.1	8.20	432	47

CASE No. 50.

DATE	ALB.	GLOB.	T.P.	ALB. / GLOB.	P.A.N.	CO_2C.P.	P.C.V.	R.B.C.	Hb.	Na.	Bl.Cl.	P.Cl. per 100ml.Pl.	P.Cl. per 100ml.Bl.	Cell Cl. per 100ml.Bl.	Cell Cl. / Plasma Cl.
Feb. 25	5.13	1.10	6.23	4.65	42.4		50			305	408	552	276	132	0.49
28	5.05	1.15	6.20	4.38		64	49			317	434	564	298	136	0.46
Mar. 2	4.84	1.35	6.19	3.59	38.4	66	48	6.10	120	318	418	554	288	130	0.45
	OPERATION														
3	4.81	1.11	5.92	4.34	44.8	65	45	5.32	110		452	572	315	137	0.43
4	4.24	1.14	5.38	3.72	32.8	64	42			321	450	570	331	119	0.36
5	4.30	1.19	5.49	3.62	32.4	70	40			326	432	562	337	95	0.28
6	4.23	1.14	5.37	3.71		73	38	5.44	112	314	456	542	336	120	0.35
7	4.37	1.20	5.57	3.64	23.2		38			323	444	542	336	108	0.32
8	4.45	1.21	5.66	3.68	25.6	61	38			324	420	536	332	88	0.27
9	4.25	1.25	5.50	3.40	27.2		38			327	468	554	344	124	0.36
10	4.43	1.29	5.72	3.44	32.8	70	36	4.84	100	328	476	560	358	118	0.33
11	4.33	1.08	5.41	4.00	34.4					327	474	556			
12			5.61		28		36			326	472	548	350	124	0.36

CASE No. 51.

DATE			ALB.	GLOB.	T.P.	ALB./GLOB.	PLASMA N.P.N.	CO_2C.P.	P.C.V.	Na	Bl.Cl.	P.Cl. per 100ml.Pl.	P.Cl. per 100ml.Bl.	Cell Cl. per 100ml.Bl.	Cell Cl./Plasma Cl.
1948	Apr.	28	4.76	1.08	5.84	4.10	34.4		48		436	568	296	140	.47
		29	4.71	1.15	5.86	4.10	33.6		48	310	440	568	296	144	.49
		30	4.76	1.35	5.91	3.53	33.6	65	49	302	436	566	289	147	.51
			OPERATION												
	May	1	4.00	1.17	5.17	3.42	24	68		299		552			
		2							36	293	440	564	361	79	.22
		3					27.6	61	32	306		556			
		5	3.91	1.70	5.61	2.30	30.4	67	30	304		552			
		6	3.83	1.70	5.53	2.25	31.2	68	30	300		552			
		7	3.79	1.60	5.39	2.37	30.4		30	310	462	566	396	66	.17
		8	4.06	1.87	5.93	2.17	29.2	62	31	311		566			
		10	4.19	1.79	5.98	2.34	28.4		32	310	450	568	400	50	.13
		12	4.23	1.90	6.13	2.23	32		35	308	478	570	370	108	.29
		14	4.13	1.80	5.93	2.29	29.2	65	34	303	468	566	362	106	.29
		19	4.45	1.86	6.31	2.39	27.2		35	320		568			

CASE No. 52.

DATE	ALB.	GLOB.	T.P.	ALB./GLOB.	N.P.N.	CO2C.P.	Na.	Pl.Cl.	P.C.V.
1948 June 9	4.61	1.35	5.96	3.42	33	64	316	576	45
11	4.61	1.36	5.97	3.39	34	68	321	580	46
	OPERATION								
12	3.88	1.25	5.13	3.10	54	66	307	544	51
14	3.68	2.05	5.73	1.79	39	66	306	514	41
15					48	68		520	39
16					45	65		500	42
17						63	309	486	44
19	3.77	1.84	5.61	2.05	32	59	301	556	41
21	3.77	1.80	5.57	2.09	32	55	319	544	37
23	3.99	1.90	5.89	2.10	33	56		558	38

CASE No. 55.

DATE	P.C.V.	CO_2C.P.	K.	P.	Bl.Cl.	P.Cl. per 100ml. plasma	P.Cl. per 100ml. Blood	Cell Cl. per 100ml. Blood	Cell Cl. / Plasma Cl.
Oct. 5	48	58			440	550	286	154	0.54
8	48	70	19.3	3.75	434	530	276	158	0.57
11	46	65	21.3	3.50	440	562	304	136	0.45
12	OPERATION								
14	42	63	20.5	2.0	424	552	320	104	0.33
16	37	65	17.2	2.50	424	550	347	77	0.22
18	42	63		3.00	442	566	328	114	0.35
21	41	55	22.6	3.50	464	568	335	129	0.39
25	40	63		3.75	454	560	336	118	0.35
28	42				440	546	317	123	0.39